Modicon M340 with Unity Pro

SSI Module BMX EAE 0300
User Manual

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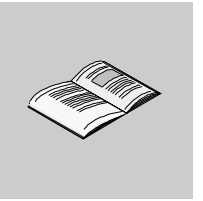

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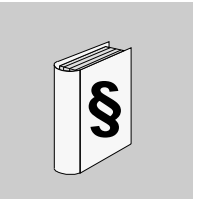
Safety Information



Important Information

NOTICE

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of this symbol to a Danger safety label indicates that an electrical hazard exists, which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ DANGER

DANGER indicates an imminently hazardous situation which, if not avoided, **will result in** death or serious injury.

⚠ WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, **can result in** death or serious injury.

⚠ CAUTION

CAUTION indicates a potentially hazardous situation which, if not avoided, **can result in** minor or moderate injury.

NOTICE

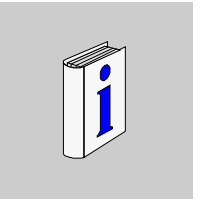
NOTICE is used to address practices not related to physical injury.

PLEASE NOTE

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and its installation, and has received safety training to recognize and avoid the hazards involved.

About the Book



At a Glance

Document Scope

This manual describes the hardware and software implementation of SSI (Synchronous Serial Interface) module BMX EAE 0300 for Modicon M340 PLCs.

Validity Note

This documentation is valid for Unity Pro 7.0.

Product Related Information

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

The application of this product requires expertise in the design and programming of control systems. Only persons with such expertise should be allowed to program, install, alter, and apply this product.

Follow all local and national safety codes and standards.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

User Comments

We welcome your comments about this document. You can reach us by e-mail at techcomm@schneider-electric.com.

BMX EAE 0300 Overview

I

Overview

This part gives an overview of the SSI module BMX EAE 0300 and its technical specifications.

What Is in This Part?

This part contains the following chapters:

Chapter	Chapter Name	Page
1	Module Introduction	11
2	SSI Module Installation	19
3	Inputs/Outputs Specifications	31

Module Introduction

1

Overview

This chapter gives an overview of the SSI module.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
General Information about SSI Functions	12
General Information about the SSI Module BMX EAE 0300	13
Physical Description of the SSI Module BMX EAE 0300	14
Characteristics of the SSI Module BMX EAE 0300	15
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General Information about SSI Functions

Overview Description

The module BMX EAE 0300 is a synchronous serial interface designed for use with an absolute encoder, it is controlled by the user applications through an open SSI interface.

The position values of the SSI channel are automatically read by the module every fixed period, unless the channel is disabled.

Available Functions

The following table presents the main functionalities of the BMX EAE 0300 module:

Function	Description
Modulo	The modulo function limits the dynamics of the position value within the power of 2. An event (if enabled) detects the modulo passing. The reflex output can also be asserted at the passing of modulo (if configured).
Reduction	This function reduces the intrinsic resolution of the encoder by a value defined by the "reduction" parameter. This reduction is carried out by a shift in the bit field provided by the encoder.
Offset	The correction function of the encoder offset systematically corrects the offset produced by the encoder at mechanical position "0". The user enters the absolute encoder offset parameter.
Capture	The two capture input registers (per channel) enable the PLC program to carry out a dynamic measurement function between two points. The capture action can be triggered by two capture inputs. The event will be triggered at each occurrence of Capture.
Compare	Two independent comparators (per channel), with thresholds that can be modified by adjustment (explicit exchange), are able to generate an event or reflex output when the threshold is crossed.

General Information about the SSI Module BMX EAE 0300

Definition

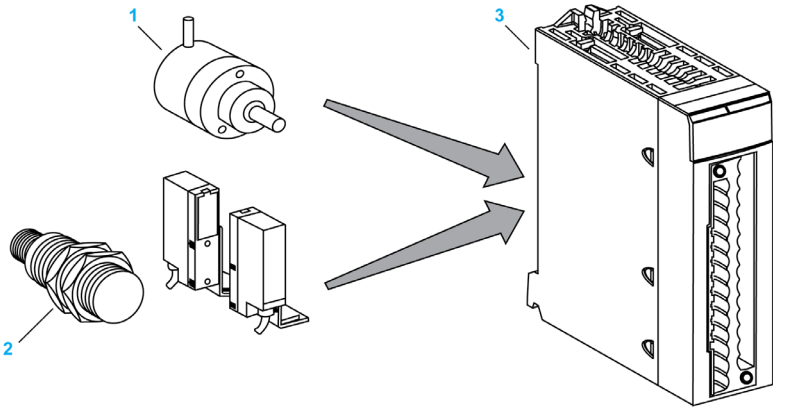
The SSI module BMX EAE 0300 is a 3-channel, synchronous serial interface, absolute encoder interface for Modicon M340 PLCs.

It supports:

- 3 channels of SSI inputs
- 1 reflex output for each SSI channel
- 2 capture inputs for the 3 SSI channels
- 8 to 31 bits data width
- 4 ranks of baud rates (100 kHz, 200 kHz, 500 kHz, 1 MHz)
- capture and compare functions

Illustration

The illustration below shows the basic components of an absolute encoder system:

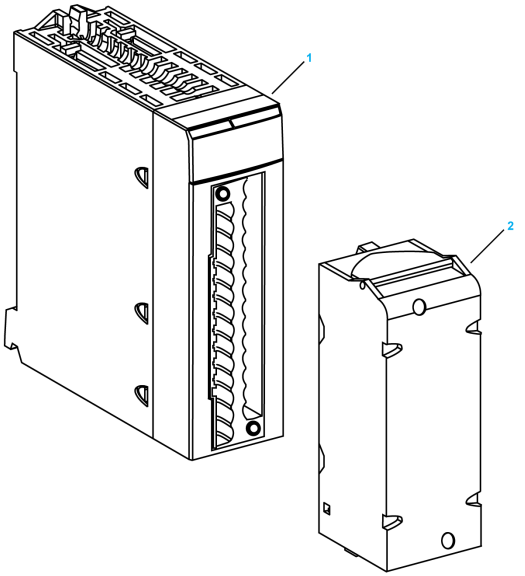


1 Absolute encoder
2 Proximity sensors
3 SSI module BMX EAE 0300

Physical Description of the SSI Module BMX EAE 0300

Illustration

The figure below presents the SSI module BMX EAE 0300:



1 BMX EAE 0300
2 28-pin removable terminal block

NOTE: The terminal block is supplied separately.

Required Accessories

The SSI module BMX EAE 0300 requires the use of the following accessories:

- 28-pin removable terminal block BMX FTB 2800/2820 *(see Modicon M340 with Unity Pro, Analog input/output modules, User manual)*
- One BMX XSP 0400/0600/0800/1200 electromagnetic compatibility kit *(see Modicon M340 Using Unity Pro, Processors, Racks, and Power Supply Modules, Setup Manual)*

Characteristics of the SSI Module BMX EAE 0300

General Characteristics

This table presents the general characteristics of the SSI module BMX EAE 0300:

SSI Channels	Maximum SSI Baud Rate	100k, 200k, 500k, 1M
	SSI Channel Number	3
	Bit Width	8 to 31 bits
	Refresh interval	= 1 ms
Regular I/O Channels	Number of Digital Inputs	Two 24 Vdc Type 3 inputs per module
	Number of Digital Outputs	One 24 Vdc output per channel
Hot Swapping Supported		Yes
Encoder Compliance		Absolute encoder 24 V model with standard SSI interface (tolerance: 19.2-30 Vdc)
Power Supply to Encoder		Voltage: 24 Vdc (Supplied by the field power) Current: < 200 mA per channel (for 24 Vdc)
Power Distribution To Encoder		Yes, short circuit limited (700 mA total)
Back Plane Power Consumption	+ 3.3 Vdc	Typical: 150 mA Maximum: 250 mA
	+ 24 Vdc	Not used
Dielectric Strength	Field To Bus	1400 Vdc for 1 min
Field Power	Voltage	19.2 to 30 Vdc (24 Vdc typical) Over-voltage protected up to 45 Vdc.
	Current	It depends on the encoder(s) and the load of reflex output consumption. For module operating: 30 mA.

NOTE: The encoder is required to have at least 5 mA output current to activate the DATA input of the SSI module.

⚠ WARNING

EQUIPMENT DAMAGE

Do not allow the supplied voltage to exceed the maximum allowed voltage of the encoder when the module BMX EAE 0300 is used to provide power to encoder.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Environment

Environmental Specifications

All parts are designed:

- for the operating range of 0° ... 60 °C (32° ... 140 °F).
- to operate at an altitude up to 4000 m (13123 ft.).

NOTE: Correction factor for 4000 m (13123 ft.) is 1.29, it is applied to all clearance and creepage distances.

All parts comply with:

- SE Eco design directives.
- European RoHS regulation and do not contain lead, mercury, cadmium, hexavalent chromium, poly-brminated biphenvls (PBB) and poly-brominatedethers.
- Chinese RoHS regulation.
- SE requirements for reduced product energy consumption during manufacture and use.
- the REACH directive.

Standards

Agency Certifications

For countrie certifications, all parts are:

- CE certified for European countries.
- UL certified for U.S.A.
- CSA certified for Canada.
- C-Tick certified for Australia.
- GOST certified for Russia.

For hazardous locations certifications, all parts are:

- FM Class1 Div2 certified.
- CSA Class1 Div2 certified.
- UL Class1 Div2 certified.
- ATEX Zone 2 certified.

SSI Module Installation

2

Overview

This chapter provides information to install the module.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
Mounting the SSI Module BMX EAE 0300	20
Mounting the BMX FTB 2800/2820 Terminal Block	22
How to Avoid Electromagnetic Interference	25
LED Indicators	27

Mounting the SSI Module BMX EAE 0300

At a Glance

Handling the module while the power supply to the rack is turned on does not disturb the PLC.

Installation Precautions

The SSI module may be installed in any of the positions in the rack except for the two slots for PS and CPU which are reserved for the rack's power supply module (BMX CPS ••••) and the processor (BMX P34 ••••) respectively. Power is supplied by the bus at the bottom of the rack (3.3 Vdc and 24 Vdc).

Before installing a module, you must take off the protective cap from the module connector located on the rack.

⚠ DANGER

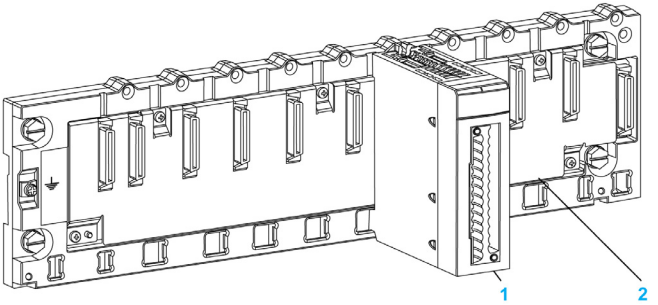
HAZARD OF ELECTRIC SHOCK

- Disconnect voltage supplying sensors and pre-actuators before plugging / unplugging the terminal block on the module.
- Remove the terminal block before plugging / unplugging the module on the rack.

Failure to follow these instructions will result in death or serious injury.

Installation

The diagram below shows SSI module BMX EAE 0300 mounted on the rack:

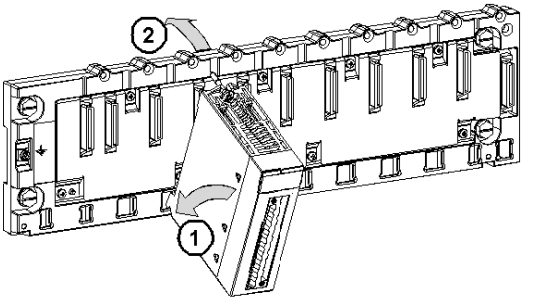
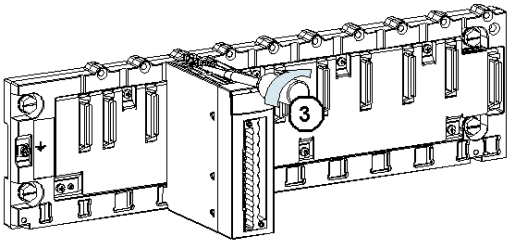


The following table describes the different elements which make up the assembly below:

Number	Description
1	SSI module BMX EAE 0300
2	Standard rack

Installing the Module on the Rack

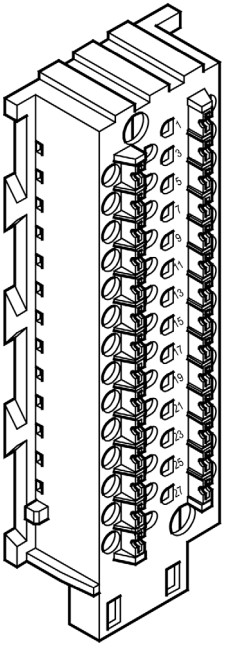
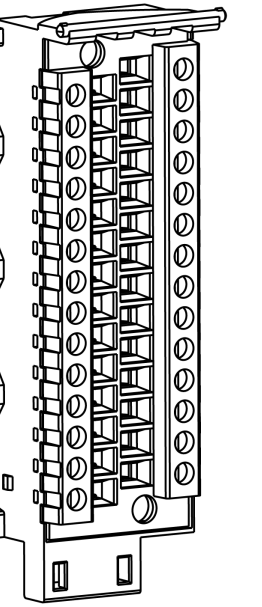
The following table shows the procedure for mounting the SSI module in the rack:

Step	Action	Illustration
1	Position the locating pins situated at the rear of the module (on the bottom part) in the corresponding slots in the rack. Note: Before positioning the pins, make sure you have removed the protective cover from the rack slot *(see Modicon M340 Using Unity Pro, Processors, Racks, and Power Supply Modules, Setup Manual)*.	Steps 1 and 2 
2	Swivel the module towards the top of the rack so that the module sits flush with the back of the rack. It is now set in position.	
3	Tighten the safety screw to ensure that the module is held in place on the rack. Tightening torque: Max. 1.5 N•m (1.10 lb-ft)	Step 3 

Mounting the BMX FTB 2800/2820 Terminal Block

Terminal Block

SSI module BMX EAE 0300 requires the BMX FTB 2800/2820 28-pin terminal block to be inserted into the front of the module. These fitting operations (assembly and disassembly) are described below.

	
BMX FTB 2820	BMX FTB 2800

Installing the 28-Pin Terminal Block

⚠ CAUTION

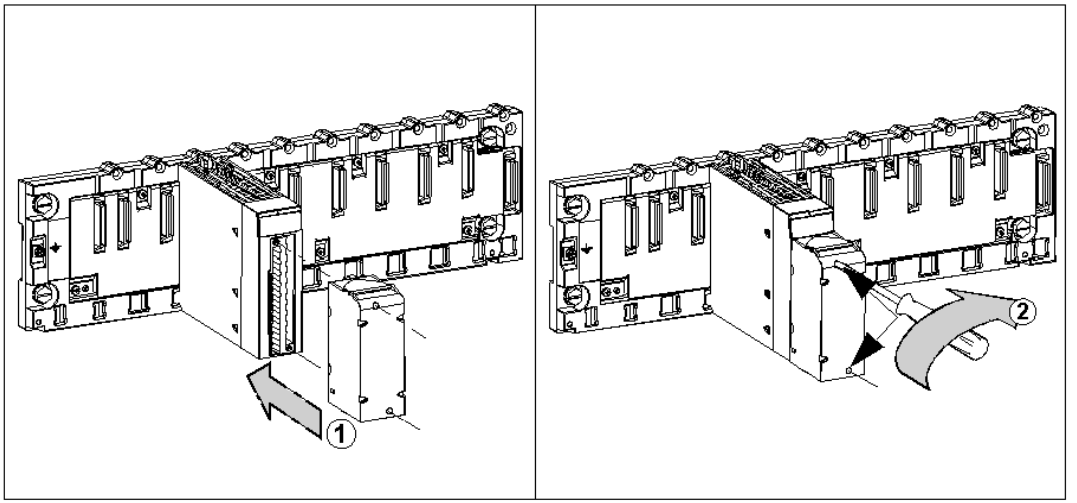
TERMINAL BLOCK IMPROPERLY FIXED TO THE MODULE

Follow the procedure instructions to fix the terminal block to the module.

Verify that the screws are tightened.

Failure to follow these instructions can result in injury or equipment damage.

The following table shows the procedure for assembling the 28-pin terminal block onto an SSI module BMX EAE 0300:

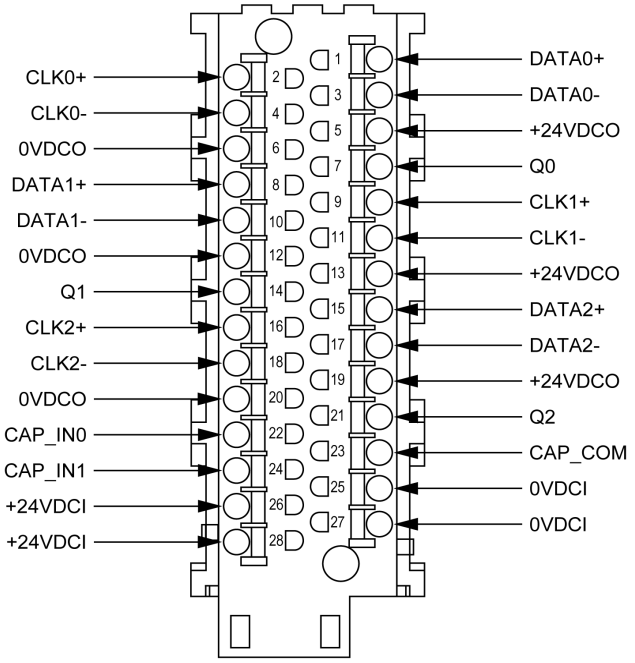


Assembly procedure:

Step	Action
1	Once the module is in place on the rack, install the terminal block by inserting the terminal block encoder (the rear lower part of the terminal) into the module's encoder (the front lower part of the module), as shown above.
2	Fix the terminal block to the module by tightening the 2 mounting screws located on the lower and upper parts of the terminal block. Tightening torque: 0•4 N.m (0.29 lb-ft).

28 Pin Terminal Block Arrangements

The terminal block is arranged as followed:



How to Avoid Electromagnetic Interference

Overview

Electromagnetic perturbations may cause the application to operate in an unexpected manner.

⚠ WARNING

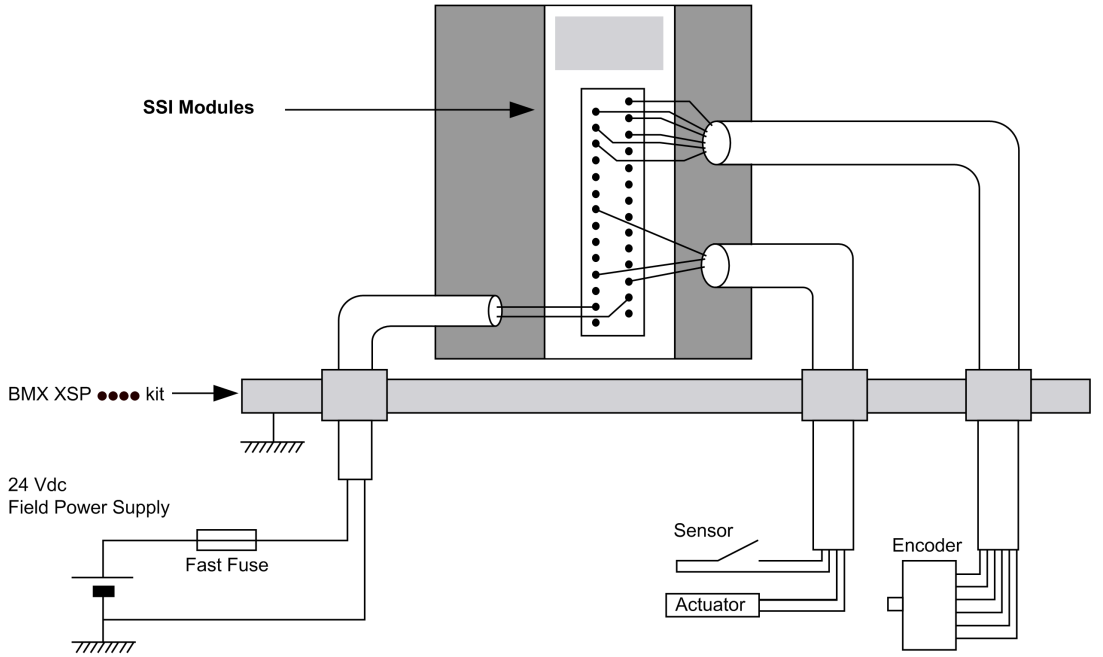
UNEXPECTED EQUIPMENT OPERATION

In a highly disturbed electromagnetic environment,

- use the BMX XSP 0400/0600/0800/1200 electromagnetic protection kit *(see Modicon M340 Using Unity Pro, Processors, Racks, and Power Supply Modules, Setup Manual)* (See Modicon M340 using Unity Pro, Processors, Racks and Power Supply Modules, BMX XSP xxx Protection Bar) to connect the shielding and
- use a stabilised 24 Vdc supply for inputs and a shielded cable for connecting the supply to the module.
- use a shielded cable for capture inputs and reflex outputs if any of them is wired.
- use a shielded cable for each SSI channel respectively and note that 24 Vdc and GND must be included in the shielded cable. (Each shielded cable includes CLK pair, DATA pair, 24Vdco, 0Vdco. If the reflex output is connected to encoder, it also has to be included.)

Failure to follow these instructions can result in death, serious injury, or equipment damage.

The figure below shows the recommended circuit for a high-noise environment using the BMX XSP 0400/0600/0800/1200 electromagnetic protection kit:



⚠ CAUTION

POTENTIAL MODULE DAMAGE - IMPROPER FUSE SELECTION

Use fast acting fuses to protect the electronic components of the module from overcurrent and reverse polarity of the input/output supplies. Improper fuse selection could result to damage to the module.

Failure to follow these instructions can result in injury or equipment damage.

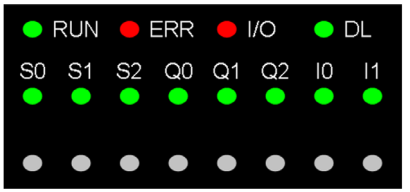
LED Indicators

At a Glance

The SSI module BMX EAE 0300 is equipped with LEDs that display the module's channels status and detected errors.

Display Panels

LED display:



The first row of LEDs indicates module information:

- LED RUN: Indicates the module's operational status
- LED ERR: indicates an internal detected fault in the module or a detected fault between the module and the rest of the configuration
- LED I/O: Indicates an external detected fault
- LED DL: Indicates the Firmware download status

The second row of LEDs corresponds to SSI channels.

The LEDs are represented in the following way: (y = 0, 1 or 2 depending on the SSI channel)

- LED Sy: Channel y Input
- LED Qy: Reflex Output for channel y
- LED I0/1: Capture Input for 3 SSI channels

When a voltage is present on an input or output, the corresponding LED is lit.

Diagnostics

The following table allows you to perform diagnostics of the module status according to the LEDs: RUN, ERR, I/O, DL and channels (LEDs S0 to I1):

Module status	**LED indicators**											
	RUN	**ERR**	**I/O**	**DL**	**S0**	**S1**	**S2**	**Q0**	**Q1**	**Q2**	**I0**	**I1**
The module is not receiving power or has inoperative	○											
The module is inoperative	○	●	○									
The module is not configured or is configuring its channels	○	⊗		○	○	○	○	○	○	○	○	○
Module has Lost communication with CPU	●	⊗		○								
Field Power Supply inoperative	●	○	●	○	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
Downloading firmware	⊗	○	○	⊗								
S0 has a detected line error	●	○	●	○	◍							
S1 has a detected line error	●	○	●	○		◍						
S2 has a detected line error	●	○	●	○			◍					
Qx has a short circuit	●	○	●	○				◍	◍	◍		
Channels are operational	●	○	○	○								
"Absolute SSI Encoder" mode is selected and no error detected	●	○	○	○	●							
	●	○	○	○		●						
	●	○	○	○			●					
Legend												
● LED on												
○ LED off												
⊗ LED flashing slowly												
◍ LED flashing fast												
An empty cell indicates that the state of the LED(s) is not taken into account												

Voltage is present on Q0	●	○	○	○				●				
Voltage is present on Q1	●	○	○	○					●			
Voltage is present on Q2	●	○	○	○						●		
Voltage is present on I0	●	○	○	○							●	
Voltage is present on I1	●	○	○	○								●

An empty cell indicates that the state of the LED(s) is not taken into account

Legend

●	LED on
○	LED off
⊗	LED flashing slowly
◍	LED flashing fast

An empty cell indicates that the state of the LED(s) is not taken into account

Inputs/Outputs Specifications

3

Overview

This chapter contains information about the inputs and outputs of the SSI module.

NOTE: The SSI performances described in this chapter are only valid with wired as indicated in this documentation.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
Capture Digital Input Characteristics	32
Reflex Digital Output Characteristics	33
Programmable Input Filtering	35

Capture Digital Input Characteristics

Capture Digital Input Characteristics

The table below describes the SSI module BMX EAE 0300 capture digital input characteristics:

Number of Input Channels		Two 24 Vdc inputs per module
IEC Type		IEC type 3
Digital Inputs: CAP_IN0 CAP_IN1	Maximum Input Voltage	30 Vdc
	ON Input Voltage	+11... +30 Vdc
	OFF Input Voltage	< 5 Vdc
	OFF Input Current	< 1.5 mA
	Nominal Input Current	(at < 30 Vdc) 5 mA
	Current at 11 Vdc	> 2 mA
	Over Voltage Protection	Maximum: 52 Vdc
	Reverse Polarity Protection	Maximum: 28 Vdc
Input Response Time		Refer to the input filter and bounce filter tables *(see page 35)*
Capture Response Time		<= 1 ms

Reflex Digital Output Characteristics

Reflex Digital Output Characteristics

The table below describes SSI module BMX EAE 0300 reflex digital output characteristics:

Number of outputs channels		One 24 Vdc 0.5 A per SSI channel, three channels per module
Output Voltage		19.2...30 Vdc (depends on field supply)
Output Type		Push-pull
Maximum Load Current	Each Point	0.5 A
	Per Module	1.5 A
Leakage / point		-0.3 mA maximum (OFF)
On State Output Voltage Drop		1.35 Vdc maximum (0.5 A)
Maximum Load Capacitance		50 µF
Maximum Load Inductance L = load inductance (Henry) I = load current (A) F = switching frequency (Hz)		0.5 Henry at 4 Hz switch frequency $L = 0.5 / (I^2 \times F)$
Maximum Physical Response Time		< 20 µs (Resistive load)
Response Time for Comparison		<= 1ms
Short Circuit		All channels are protected against short circuit and over temperature
Fallback States (Output Channels)	By default	Pre-defined fallback values on all channels
	User - Configurable Setting	Hold last value
		Pre-defined fallback value on one or all channels
Pre-defined Values (Output Fallback)	By default	Channels set to 0
	User - Configurable Setting	Each channel configurable for 1 or 0
Polarity On Individual Output Channels	By default	Logic normal on all channels
	User - Configurable Setting	Logic reverse on one or all channels
		Logic normal on one or all channels

⚠ WARNING

OUTPUT SHORT-CIRCUIT OR OVERLOAD

Do not apply a high voltage (24 Vdc) to an output port when it is at "0" because there is no internal short circuit protection.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

NOTE:

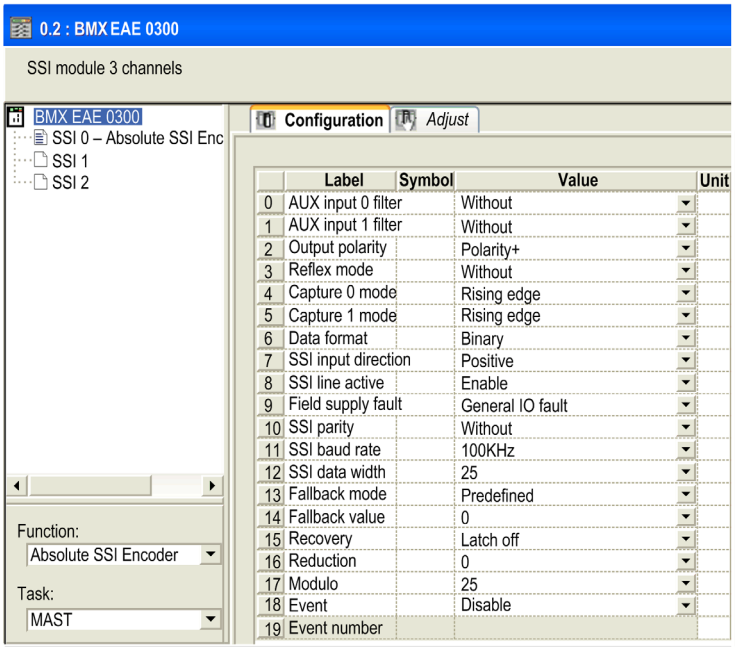
If the short circuit occurs on any channel, the power supply goes into the following mode:

- Firstly the power supply cycles on as the hiccup mode, the peak current is less than 10 A with about a 2 µs duration.
- Then all channels are turned off after about 100 ms

Programmable Input Filtering

Overivew

Each of the SSI module BMX EAE 0300 inputs allows input filtering. There are four levels of filtering available (low, medium, high and without), that can be configured in the configuration screen, as shown:

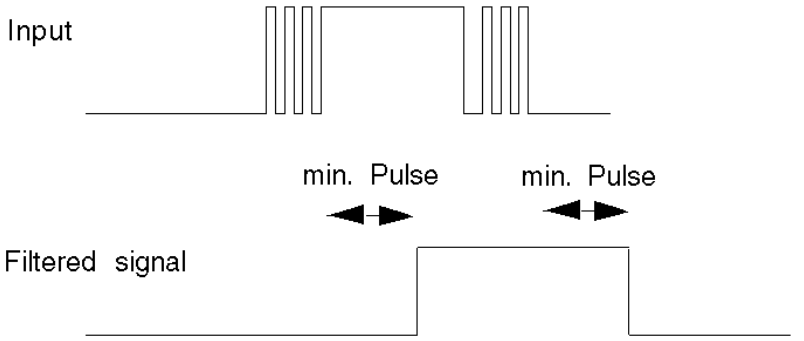


	Label	Symbol	Value	Unit
0	AUX input 0 filter		Without	
1	AUX input 1 filter		Without	
2	Output polarity		Polarity+	
3	Reflex mode		Without	
4	Capture 0 mode		Rising edge	
5	Capture 1 mode		Rising edge	
6	Data format		Binary	
7	SSI input direction		Positive	
8	SSI line active		Enable	
9	Field supply fault		General IO fault	
10	SSI parity		Without	
11	SSI baud rate		100KHz	
12	SSI data width		25	
13	Fallback mode		Predefined	
14	Fallback value		0	
15	Recovery		Latch off	
16	Reduction		0	
17	Modulo		25	
18	Event		Disable	
19	Event number			

Description

The filtering used is a programmable bounce filter, which operates as follows:

Bounce rejection diagram



In bounce rejection mode, the system delays all transitions until the signal remains stable for the duration defined for the filter level.

Bounce rejection levels:

Input	Filter Level	Min Pulse	Max Frequency
CAP_IN0,1	Without	20 µs	200 Hz
	Low (For Bounces > 2 kHz)	500 µs	200 Hz
	Medium (For Bounces > 1 kHz)	1.25 ms	200 Hz
	High (For Bounces > 250 Hz)	4.2 ms	100 Hz

SSI Module BMX EAE 0300 Functionalities

II

Subject of this Part

This part presents the functionalities of the SSI module BMX EAE 0300.

What Is in This Part?

This part contains the following chapters:

Chapter	Chapter Name	Page
4	Configuration parameters	39
5	SSI Module BMX EAE 0300 Functions	41
6	Adjustment	57
7	Debugging the SSI Module BMX EAE 0300	59
8	Diagnostic of the SSI Module BMX EAE 0300	61
9	The Language Objects of the SSI Function	63

Configuration parameters

4

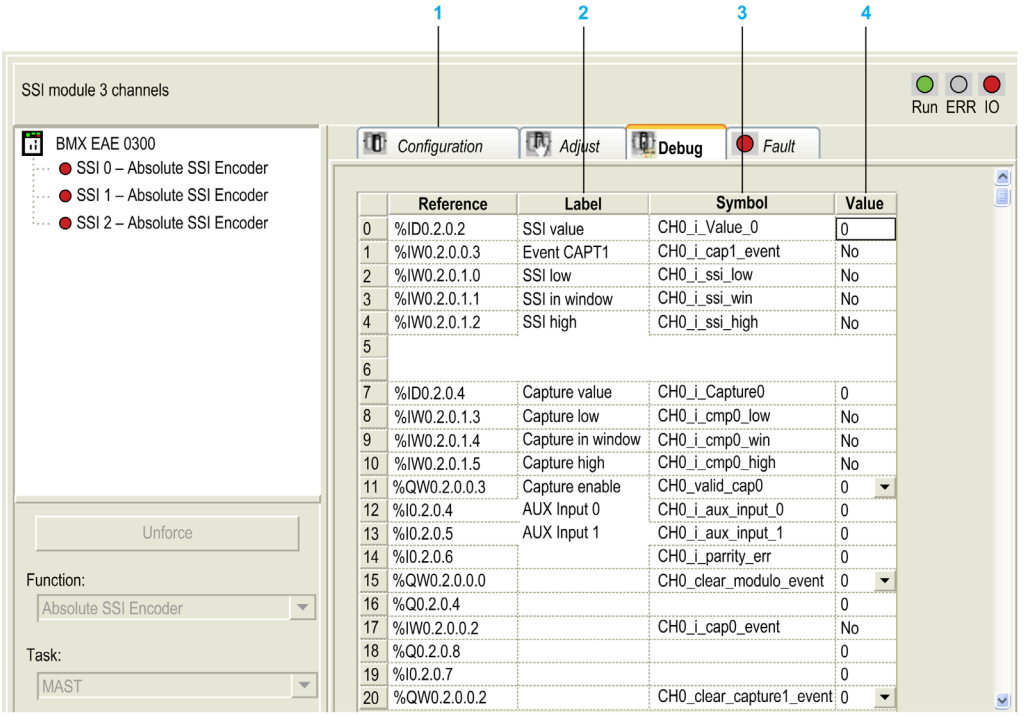
Configuration Screen for the SSI Module BMX EAE 0300

At a Glance

This section presents the configuration screen for the SSI module BMX EAE 0300.

Illustration

The figure below presents the configuration screen for the SSI module BMX EAE 0300:



	Reference	Label	Symbol	Value
0	%ID0.2.0.2	SSI value	CH0_i_Value_0	0
1	%IW0.2.0.0.3	Event CAPT1	CH0_i_cap1_event	No
2	%IW0.2.0.1.0	SSI low	CH0_i_ssi_low	No
3	%IW0.2.0.1.1	SSI in window	CH0_i_ssi_win	No
4	%IW0.2.0.1.2	SSI high	CH0_i_ssi_high	No
5				
6				
7	%ID0.2.0.4	Capture value	CH0_i_Capture0	0
8	%IW0.2.0.1.3	Capture low	CH0_i_cmp0_low	No
9	%IW0.2.0.1.4	Capture in window	CH0_i_cmp0_win	No
10	%IW0.2.0.1.5	Capture high	CH0_i_cmp0_high	No
11	%QW0.2.0.0.3	Capture enable	CH0_valid_cap0	0
12	%I0.2.0.4	AUX Input 0	CH0_i_aux_input_0	0
13	%I0.2.0.5	AUX Input 1	CH0_i_aux_input_1	0
14	%I0.2.0.6		CH0_i_parrity_err	0
15	%QW0.2.0.0.0		CH0_clear_modulo_event	0
16	%Q0.2.0.4			0
17	%IW0.2.0.0.2		CH0_i_cap0_event	No
18	%Q0.2.0.8			0
19	%I0.2.0.7			0
20	%QW0.2.0.0.2		CH0_clear_capture1_event	0

Description of the Screen

The following table presents the various parts of the above screen:

Number	Column	Function
1	Tab	The tab in the foreground indicates the current mode. The current mode is the configuration mode in this example.
2	**Label**	These fields contain the name of each variable that may be configured. They may not be modified.
3	**Symbol**	These fields contain the address of the variable in the application. They may not be modified.
4	**Value**	If these fields have a downward pointing arrow, you can select the value of each variable from various possible values in these fields. The various values can be accessed by clicking on the arrow. A drop-down menu containing all the possible values is displayed and the user may then select the required value of the variable.
5	**Unit**	These fields contain the unit of each variable that may be configured. They may not be modified.

NOTE: Refer to the desired function *(see page 41)* in order to properly configure the SSI module BMX EAE 0300.

SSI Module BMX EAE 0300 Functions

5

Overview

This chapter deals with functions of the SSI module BMX EAE 0300.

What Is in This Chapter?

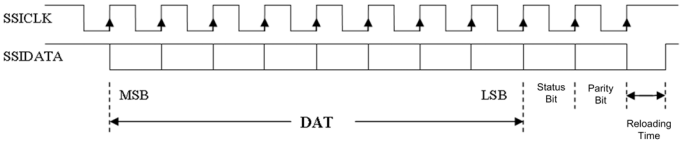
This chapter contains the following topics:

Topic	Page
SSI Interface	42
Modulo and Reduction Functions	43
Offset Function	44
Inverted SSI Direction Function	45
Multiple Application of Reformatting	46
Capture Function	47
Compare Function	49
SSI Status Register	52
Event Sent To Application	53
Output Block Functions	54

SSI Interface

Description of the SSI Interface

The figure below represents a SSI frame:



NOTE: This module does not control the turn value. For multi-turn encoders, the angle and turn values constitute a single and unique value for the module.

The following are the other main characteristics of the frame and the interface:

Parameters	**Values or observations**
Code	Binary or Gray
SSI transmission baud rate	100 kHz, 200 kHz, 500 kHz or 1 MHz
Data bits	8 to 31 bits (MSB transferred first)
Status bits	0 to 1 bit (error bit may be handled by firmware)
Parity	Even, Odd or Without parity
Reloading Time	10 to 40 µs depending on encoder

Parameter Details

There are four choices for the baud rate parameter which impact the maximum cable length:

Baud rate	100 kHz	200 kHz	500 kHz	1 MHz
Maximum cable length	350 m	180 m	70 m	20 m

The **data bits** parameter enables the number of data bits supplied by the encoder to be declared (from MSB to LSB). The upper limit is 31.

The **Status bit** is the status flag which is refreshed when receiving this bit in the sequence. For some encorders, this bit can indicate the detected error in the data frame.

The **Parity** parameter enables a **Parity bit** to be declared in the frame. If the parity bit is selected, the modules carry out the parity check according to the choice of parity type, even or odd.

After the last rising edge of the clock signal, the **Reloading time** defines how long it takes until the rotary encoder can be selected for the next transmission. This reloading time is determined by the period of SSI pulse train. The reading cycle of SSI module is fixed by 1 ms.

Modulo and Reduction Functions

Description

The two functions are:

- **Modulo**: the modulo function limits the dynamics of the position value to within a number of points defined by the value of the parameter. An event (if enabled) detects the modulo (positive or negative) passing.
- **Reduction**: the function reduces the intrinsic resolution of the encoder by a value defined by the "reduction" parameter. This reduction is carried out by a shift in the bits field provided by the encoder.

The two parameters are of a "constant configuration" (%K) type.

Details for Modulo and Reduction

- The modulo and reduction value is expressed as the exponent of 2.
- The number of modulo bits is limited from 8 to 31 while the number of reduction bits is limited from 0 to 7 bit.
- When the reflex output is asserted ("1") by the presence of modulo value passing, it will keep the value "1" until a rising edge of an extra clear bit of %Q occurs.

The modulo passing detection is only available when module < data width.

For example: if the data width is 13-bit, then the modulo passing will not be detected when the modulo is from 13 to 31. (The default value of modulo is 31.)

Offset Function

Description

NOTE: The **Encoder offset** parameters are set in the `Adjust` tab.

Encoder offset: the user enters the absolute encoder offset parameter. The correction function of the encoder offset systematically corrects the offset produced by the encoder on mechanical position "0". This value is set in an adjustment word (%MW).

Inverted SSI Direction Function

Description

If the direction of input SSI data is inverted by the configuration, the output data is transferred by the following equation:

Inverted_value = 2^N - **Original_value**

N: encoder data width.

NOTE: Inverted_0 = 0.

Multiple Application of Reformatting

Description

In case the user applies all the reformatting function at the same time, it is necessary to define the priority of them: **Invert** > **Reduction** > **Offset** > **Modulo**.

Example

With the following conditions:

Data_width = 11 bits

Modulo = 256 (8 bits)

Reduction = 1 bit

Enter the offset value after reduction.

In this example, because the full range resolution becomes 2^{11-1} after reduction, to have a physical offset of half range, the offset value should be set as:

Offset = 512

After the offset value has been added, if the reformatted value exceeds 2^{11-1}, then the value will be masked by 2^{11-1}.

If the original data is 00001001001 in binary (73 in decimal), while SSI direction is inverted:

Invert [73] = 2^{11} - **73** = **1975**

Reduct [1975] = **1975** / 2^{1} = **987**

Offset [987] = **987** + 512 - 2^{11-1} = **475**

Mod [475/256] = **219**

The final result in `%IW` is 219. As to the Gray code, it will be converted by XCEL automatically. The original data in SSI register is always in binary.

Capture Function

Description

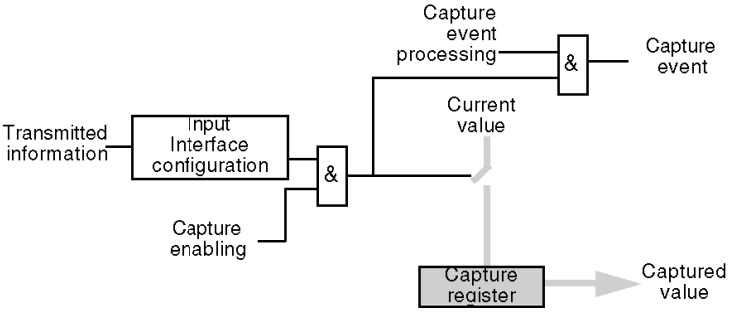
Capture is used to copy the current value of the SSI register to a capture register. It fixes the immediate value at the precise moment the operation started.

The SSI module has two capture inputs, CAP_IN0 and CAP_IN1 respectively.

The **Capture done** information is an event which can undergo an event processing operation.

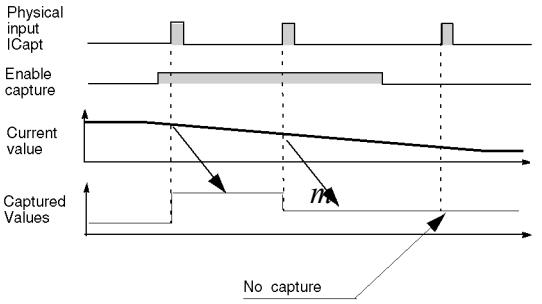
Function Hardware Structure

The figure below shows the hardware structure of the capture function:



Operation

The trend diagram below shows the capture mode on the rising edge of **CAP_IN**:



The other mode (capture on falling edge) is similar.

Details of Capture Function

- The operation is triggered by the hardware when a CAP_IN physical input status is changed when the capture enabling command is enabled. The SSi module capture modes are:
  - Capture on rising edge of an CAP_IN input.
    The capture value is recorded in the Capture Register 0 for CAP_IN0, and in the Capture Register 1 for CAP_IN1.
  - Capture on falling edge of an CAP_IN input.
    The capture value is recorded in the Capture Register 0 for CAP_IN0, and in Capture Register 1 for CAP_IN1.
- If the Modulo *(see page 43)*, Reduction *(see page 43)*, Offset *(see page 44)* and SSI direction *(see page 45)* functions have been applied, the captured value is affected as well.
- The current value of SSI register must be valid before the event. If the Validity bit is false (low) the capture is not performed.
- The three SSI channels share the common capture inputs of CAP_IN0 and CAP_IN1. The capture action of unwanted channel(s) can be disabled by the validate bit.

Example Capture on Rising or Falling Edge

The capture mode on the rising or falling edge of a physical input can be used to monitor the progress of the manufacture of a part. This means that the position of the encoder can be captured when part enters.

Compare Function

Description

The comparison function allows triggering event tasks or a reflex output according to the current value in comparison to a threshold. The SSI module has two comparators. The comparison is made in both directions (upper threshold and lower threshold).

Example with Compare

These comparators can be used to warn that a position has been exceeded. As soon as the current value reaches the threshold, the event task associated with the module is called and can activate an alarm to inform you of the end of a maneuver.

Comparison Thresholds

The comparison block has two thresholds:

- The upper threshold: `upper_th_value` double word (`%QDr.m.c.6`)
- The lower threshold: `lower_th_value` double word (`%QDr.m.c.4`)

The upper threshold value must be greater than or equal to the lower threshold value.

If the upper threshold is less than the lower threshold, the threshold error bit (`%IWr.m.c.1` x9) is asserted and all the compare functions of this channel are disabled.

The default value of `upper_th_value` and `lower_th_value` is 0.

⚠ WARNING

UNEXPECTED REFLEX OUTPUT BEHAVIOR

Set right value in `upper_th_value` and `lower_th_value` before activating the compare enable bit.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Comparison Status Register

The results of comparison are stored in the output word named `compare_status` register.

The two thresholds may be compared with the:
- current value of SSI register
- value of capture register 0
- value of capture register 1

NOTE: The compare results for all the three modes can only be handled by a firmware interrupt, the delay of the reaction depends on the interrupt priority and the system response time (for example, 1 ms).

The possible results are:
- Low: The value is less than the lower threshold value.
- Window: The value is between the upper and lower thresholds or equal to one of the two thresholds.
- High: The value is greater than the upper threshold.

The `compare_status` register (`%IWr.m.c.1`) consists of:

Status register bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Compared element								Capture 1			Capture 0			SSI Register		
Comparison result								High	Win-dow	Low	High	Win-dow	Low	High	Win-dow	Low

Register Updates

When the validate bit is False (Low), the compare status register is cleared.

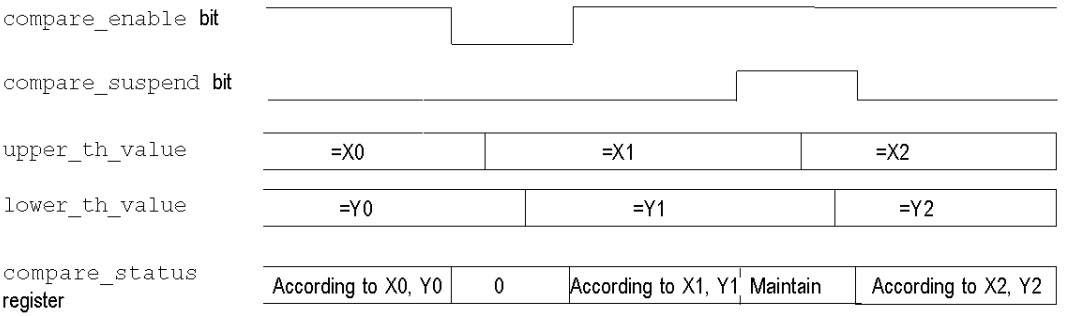
Update Time:
- The comparison with capture 0 and capture 1 registers values is performed every time the registers are loaded.
- The comparison with the SSI register occurs for each refreshed value (each 1 ms).

Modification of the Thresholds during the Operational Phase

If the application needs to modify the thresholds during the running of the SSI input, the **Compare Suspend Bit** holds the **Compare Status Register** during the modification of threshold.

Compare Status Register needs the **Compare Enable Bit** set active (1) and **Compare Suspend Bit** set inactive (0) to be updated. Both **Compare Enable Bit** and **Compare Suspend Bit** are set through the Output Word.

The following figure illustrates the actions of the `compare_enable` bit (`%QWr.m.c.0.5`) and the `compare_suspend` bit (`%QWr.m.c.0.6`):



When **Compare Enable Bit** is False, the **compare status register** is cleared.

When **Compare Suspend Bit** is true, the **compare status register** holds the previous result of comparison until this bit becomes "0" again.

The threshold is updated if the channel gets the falling edge of the **Compare Suspend Bit**. For example: at the moment that the **Compare Suspend Bit** turns from 1 to 0, the SSI module update the threshold with the newest value in `%QW`.

NOTE: The user must enter the thresholds which are reformatting (modulo, reduction, offset and direction reversed) if any reformatting function is applied.

SSI Status Register

Modulo Bit

This bit is used to detect the passing of modulo. It is set (active "1") when the SSI Encoder value passes the modulo, and it does not return to "0" unless the application clears (reset) the flag by using the output command bit: Reset_Modulo_Flag.

Capture Event Bit

This bit is used to report the occurrence of a capture action. "1" indicates that there was a capture action, "0" means no capture occurred so far. Once it is set, this bit stays at "1" until it is cleared by the application by output command bit of Reset_Capture_Flag.

Frame Error Bit

This bit reports any detected error during the sequence. The Line_err bit is also reported via this bit. The detected line error, such as the drop of line, changes the status of Frame Error bit to "1".

NOTE: The BMX EAE 0300 module asserts a frame error (line drop) by seeing an all "1" frame (internally pull-up). This means in case the real input position is just an all "1" frame, the frame error bit will also be set and the current value (all "1") will not be updated to the SSI register. The position value will be updated once the encoder leaves the all "1" position.

The user is suggested to walk around the all "1" position by using the multi-turn encoder or set the appropriate modulo / reduction parameter.

Status Bit

This bit provided by the encoder, which follows the LSB in the sequence is usually used to indicate a detected error from the encoder.

NOTE: If the status bit is supported by the encoder, you should use it to detect when a wrong frame has been sent.

Parity Bit

This bit indicates a parity error. "1" means the occurrence of detected error.

NOTE: If the parity bit is supported by the encoder, you should use it to detect when the frame has been corrupted during transfer.

Event Sent To Application

Summary

The number of the event task must be declared in the module configuration screen.

The M340 SSI module includes 6 sources of events:

Source Name	Comment
Modulo	Event when the SSI value passed modulo
SSI Low	Event when the SSI value is lower than the lower threshold
SSI Window	Event when the SSI value is within [lower threshold, upper threshold]
SSI High	Event when the SSI value is greater than the upper threshold
Capture 0	Event when capture register 0 updates
Capture 1	Event when capture register 1 updates

All the events sent by the module, regardless of the source, call the same single event task in the PLC.

There is normally only one type of event signaled per call. The source producing the call is determined in the event task via the Events Source variable. This variable is updated at the beginning of event task processing.

NOTE: If two or more event sources occur in the same 1 ms cycle, then multiple events will be sent (one event for one source).

Event Validate Description

When an action comes from an external event, this action must be validated before affecting the application. There is one (Function)_Validation bit by function which can be impacted by an external event.

Example Using Capture CAP_IN

This function holds the current SSI value in the Capture 0 register.

- **Valid_Capture0:** When it is asserted as "1", it allows loading the current SSI value into the Capture 0 register consequential to the CAP_IN0 *(see page 48)*. When it is "0", the value in the capture register 0 will not change.
- **Valid_Capture1:** When it is asserted as "1", it allows loading the current SSI value into the Capture 1 register consequential to the CAP_IN1 *(see page 48)*. When it is "0", the value in the capture register 1 will not change.

NOTE: In order to make a capture happen, besides the validate bit, the corresponding configuration (%K) must be set also.

Output Block Functions

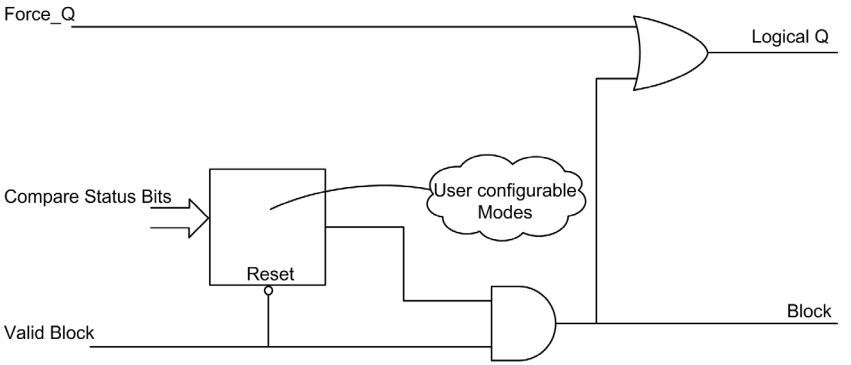
Overview

Every channel in the SSI module has one programmable output block that operates with the Compare Status Register and affects the behavior of physical outputs Qx for each channel.

There are two ways to control the output:

- From the application: the output corresponds to the status of the output bit from the output command bit.
- From the output function block: the user must enable the output block function. Then, the output corresponds to the status of the output bit from the function block.

The following figure shows the output function block Q0:



Configurable Functions

The operational Latch Mode must be chosen among 11 functions in configuration tab.

As stated, the output comes:

- Directly, from the application software (Normal Output): 1 function.
- From the output function block (Reflex Output): 10 functions.
  The output matches the state of the output bit in the output function block result.

The table below shows the configurable functions:

Function code	Programming
0	No reflex action (default)
1	**SSI value low** The output is high if the SSI value is less than the lower threshold.
2	**SSI value in a window** The output is high if the SSI value is between the upper and lower thresholds or equal to one of the two thresholds.
3	**SSI value high** The output is high if the SSI value is greater than the upper threshold.
4	**Capture 0 low** The output is high if the capture 0 value is less than the lower threshold.
5	**Capture 0 in a window** The output is high if the capture 0 value is between the upper and lower thresholds or equal to one of the two thresholds.
6	**Capture 0 high** The output is high if the capture 0 value is greater than the upper threshold.
7	**Capture 1 low** The output is high if the capture 1 value is less than the lower threshold.
8	**Capture 1 in a window** The output is high if the capture 1 value is between the upper and lower thresholds or equal to one of the two thresholds.
9	**Capture 1 high** The output is high if the capture 1 value is greater than the upper threshold.
10	**Modulo Passing** The output is high if the SSI encoder value changes from lower to upper than the modulo or from upper to lower direction.

Output Properties

The SSI module BMX EAE 0300 enables output signals to be adapted with three 24 Vdc field actuators.

It is possible to configure the following parameters for each output:

- Logic normal or logic reverse **output polarity** for each channel on the module
- **Fallback mode** and state for every module channel

Detected Error Recovery

Outputs Q0, Q1 and Q2 are current limited (0.5 A maximum).

A thermal shutdown protects each output.

When a short-circuit is detected on one of the output channels, the SSI module latches off the output channel.

If an output channel has been latched off because of short-circuit detection, the SSI module recovers from the short-circuit after the following sequence is processed:

- The short-circuit has been corrected
- To reset the detected error, the application must:
  - Reset the `output_block_enable` bit if it is active
  - Command the ouput to 0 Vdc (depends on the polarity).

NOTE: A minimum delay of 10 s occurs before the detected error is cleared.

Output Polarity Programming

By default, the `polarity` on all output channels is logic normal, where:

- 0 indicates that the physical actuator is off (the output signal is low)
- 1 indicates that the physical actuator is on (the output signal is high)

It is possible to configure the `polarity` parameter for each output during the channel configuration to "1" or "0".

Output Fallback Modes

The fallback modes are the predefined states to which the output channels revert when the channel is not controlled by the processor (for example, when communications are lost or when the processor is stopped).

The fallback mode of each output channel can be configured as one of the following modes:

- `Predefined state`: you may configure the fallback value as 0 or 1
- `Hold last value`: the output block function continues to operate according to the last received commands.

NOTE: By default, the fallback mode of the 3 output channels is `Predefined state`; the `fallback value` parameter is `0`.

Adjustment

6

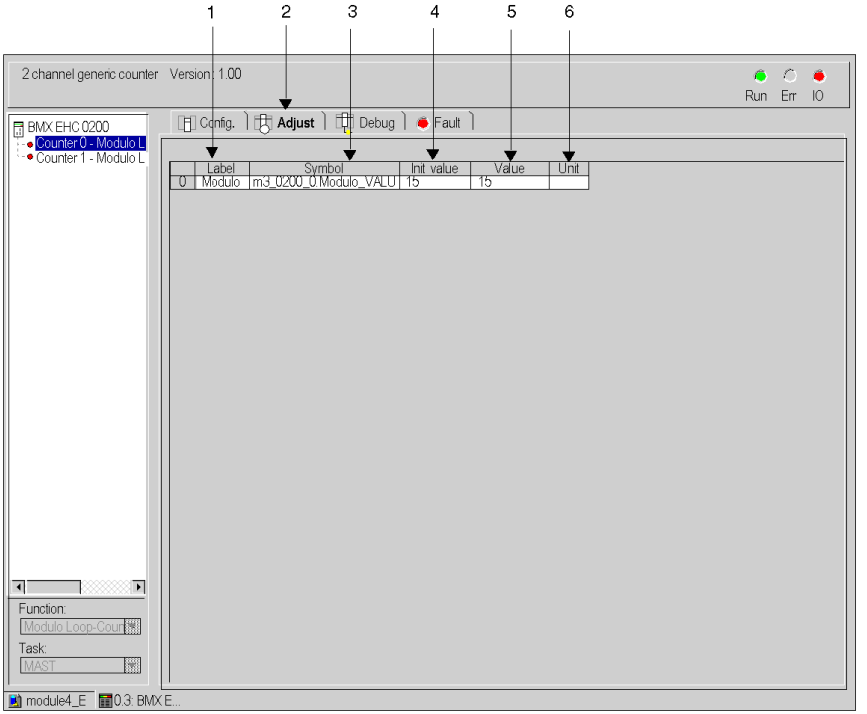
Screen for the SSI Module BMX EAE 0300

At a Glance

This chapter presents the adjust screen for the SSI module BMX EAE 0300.

Illustration

The figure below presents the Adjust screen for the SSI module BMX EAE 0300 in absolute SSI encoder mode:



Description of the Screen

The following table presents the various parts of the above screen:

Number	Column	Function
1	**Label**	These fields contain the name of each variable that may be adjusted. They may not be modified and can be accessed in both local and online modes.
2	Tab	The tab in the foreground indicates the current mode. The current mode is therefore the adjust mode in this example.
3	**Symbol**	These fields contain the mnemonic name of the variable. They may not be modified and can be accessed in both offline and online modes.
4	**Initial value**	These fields display the value of the variable that the user has adjusted in offline mode. They are only accessible in online mode.
5	**Value**	The function of these fields depends on the mode in which the user is working: ● **In offline mode**: these field are used to adjust the variable. ● **In online mode**: these field are used to display the current value of the variable.
6	**Unit**	These fields contain the unit of each variable that may be configured. They may not be modified and can be accessed in both offline and online modes.

Debugging the SSI Module BMX EAE 0300

7

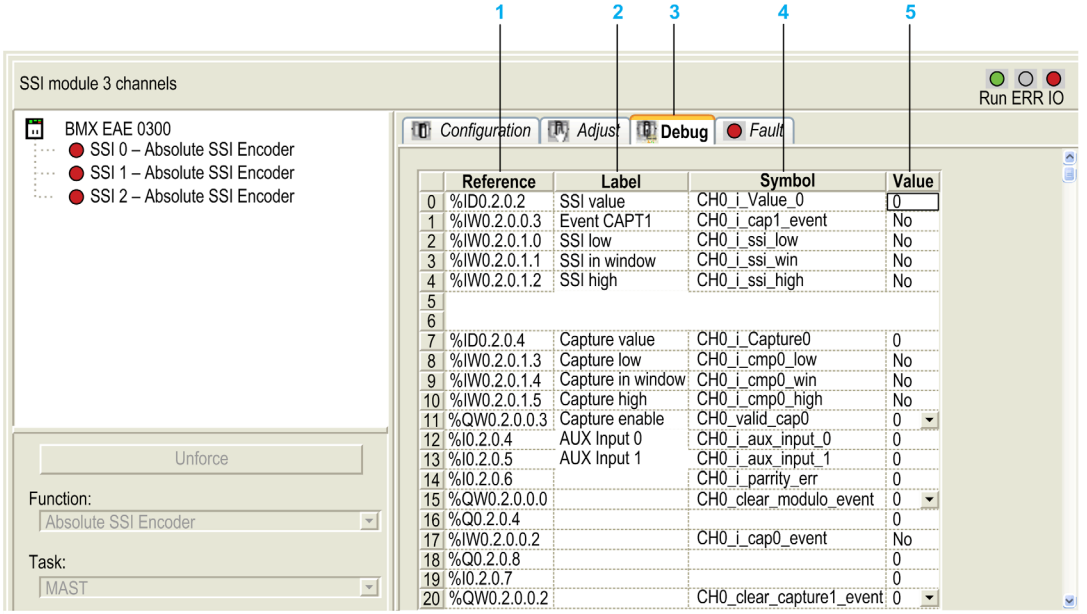
Debug Screen for the SSI Module BMX EAE 0300

At a Glance

This chapter presents the debug screen for the SSI module BMX EAE 0300. The Debug screen can only be accessed in online mode.

Illustration

The screen presents the debug screen for the SSI module BMX EAE 0300:



	Reference	Label	Symbol	Value
0	%ID0.2.0.2	SSI value	CH0_i_Value_0	0
1	%IW0.2.0.0.3	Event CAPT1	CH0_i_cap1_event	No
2	%IW0.2.0.1.0	SSI low	CH0_i_ssi_low	No
3	%IW0.2.0.1.1	SSI in window	CH0_i_ssi_win	No
4	%IW0.2.0.1.2	SSI high	CH0_i_ssi_high	No
5				
6				
7	%ID0.2.0.4	Capture value	CH0_i_Capture0	0
8	%IW0.2.0.1.3	Capture low	CH0_i_cmp0_low	No
9	%IW0.2.0.1.4	Capture in window	CH0_i_cmp0_win	No
10	%IW0.2.0.1.5	Capture high	CH0_i_cmp0_high	No
11	%QW0.2.0.0.3	Capture enable	CH0_valid_cap0	0
12	%I0.2.0.4	AUX Input 0	CH0_i_aux_input_0	0
13	%I0.2.0.5	AUX Input 1	CH0_i_aux_input_1	0
14	%I0.2.0.6		CH0_i_parrity_err	0
15	%QW0.2.0.0.0		CH0_clear_modulo_event	0
16	%Q0.2.0.4			0
17	%IW0.2.0.0.2		CH0_i_cap0_event	No
18	%Q0.2.0.8			0
19	%I0.2.0.7			0
20	%QW0.2.0.0.2		CH0_clear_capture1_event	0

Description of the Screen

The following table presents the various parts of the Debug screen:

Number	Column	Function
1	**Reference**	These fields contain the address of the variable in the application. They may not be modified.
2	**Label**	These fields contain the name of each variable that may be configured. They may not be modified.
3	Tab	The tab in the foreground indicates the current mode. The current mode is the **debug** mode in this example.
4	**Symbol**	These fields contain the mnemonic name of the variable. They may not be modified.
5	**Value**	If the fields have a downward pointing arrow, you can select the value of each variable from various possible values in these fields. The various values can be accessed by clicking on the arrow. A drop-down menu containing all the possible values is displayed and the user may then select the required value of the variable. If there is no downward pointing arrow, these fields simply display the current value of the variable.

Diagnostic of the SSI Module BMX EAE 0300

8

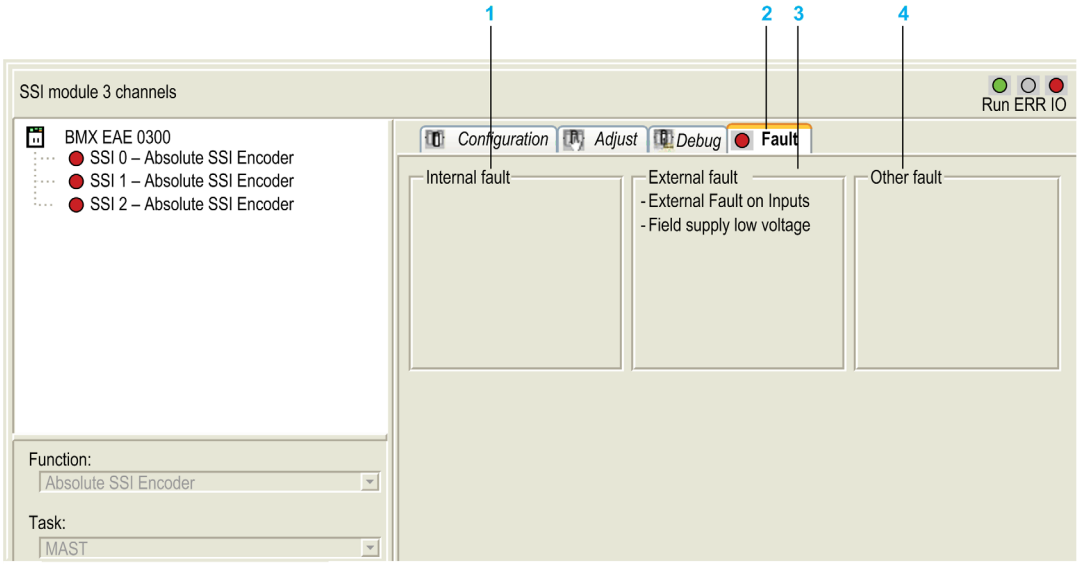
Diagnostic Screen for the SSI Module BMX EAE 0300

At a Glance

This chapter presents the fault display screen for the SSI module BMX EAE 0300. A fault display screen of module may only be accessed in online mode.

Illustration

The figure below presents the Diagnostic Screen for the SSI module BMX EAE 0300 in position control mode.



Description of the Screen

The following table presents the various parts of the Diagnostic screen:

Number	Column	Function
1	Internal faults	These fields display the module's active detected internal errors.
2	Tab	This tab in the foreground indicates the current mode. The current mode is the Fault display mode in this example.
3	External faults	These fields display the module's active detected external errors.
4	Other faults	These fields display the module's active detected errors, other than internal and detected external errors.

Description of the Fault Type

The following table presents the list of detected error types:

Number	Fault type	Name	Display
0	**External**	**EXT0_FLT**	External Fault on Inputs
1	**External**	**EXT1_FLT**	External Fault on Outputs
2	**Internal**	**INTERNAL_FLT**	Faulty channel
3	**Internal**	**CONF_FLT**	Detected hardware or software configuration fault
4	**Internal**	**COM_FLT**	Module missing or off (interruption of communication with PLC)
5	**Internal**	**APPLI_FLT**	Application mistake (configuration or adjustment)
6	**External**	**Field Supply**	Field supply low voltage
7	**External**	**S_Circuit OUT**	Reflex Output (24 Vdc) inoperative after Short Circuit

The Language Objects of the SSI Function

9

Overview

This chapter describes the language objects associated to the SSI module BMX EAE 0300 tasks as well as the different ways of using them.

What Is in This Chapter?

This chapter contains the following sections:

Section	Topic	Page
9.1	The Language Objects and IODDT of the SSI Function	64
9.2	Language Objects and IODDTs Associated with the SSI Function	73
9.3	The IODDT Type T_GEN_MOD Applicable to All Modules	79

9.1 The Language Objects and IODDT of the SSI Function

At a Glance

This section presents an overview of the position control IODDT languages and objects.

What Is in This Section?

This section contains the following topics:

Topic	Page
Introducing Language Objects for Application-Specific SSI	65
Implicit Exchange Language Objects Associated with the Application-Specific Function	66
Explicit Exchange Language Objects Associated with the Application-Specific Functions	67
Management of Exchanges and Reports with Explicit Objects	69

Introducing Language Objects for Application-Specific SSI

Language Object Types

There are two types of language objects:

- **Implicit Exchange Objects:** these objects are automatically exchanged on each cycle revolution of the task associated with the module
  Implicit exchanges concern the inputs/outputs of the module (measurement results, information and commands). These exchanges enable the debugging of the counting modules.
- **Explicit Exchange Objects:** these objects are exchanged on the application's request, using explicit exchange instructions
  Explicit exchanges enable the module to be set and diagnosed.

Implicit Exchange Language Objects Associated with the Application-Specific Function

At a Glance

An integrated application-specific interface or the addition of a module automatically enhances the language objects application used to program this interface or module.

These objects correspond to the input/output images and software data of the module or integrated application-specific interface.

Module Inputs

The module inputs (%I and %IW) are updated in the PLC memory at the start of the task, the PLC being in RUN or STOP mode.

The outputs (%Q and %QW) are updated at the end of the task, only when the PLC is in RUN mode.

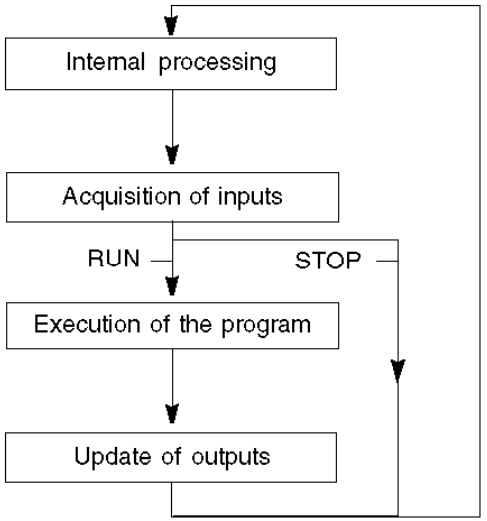
NOTE:

When the task occurs in STOP mode, either of the following are possible, depending on the configuration selected:

- outputs are set to fallback position (fallback mode)
- outputs are maintained at their last value (maintain mode)

Operating Cycle of a PLC Task

The following diagram shows the cyclical execution of a PLC task.



Explicit Exchange Language Objects Associated with the Application-Specific Functions

Introduction

Explicit exchanges are performed at the user program's request using these instructions:

- READ_STS *(see Unity Pro, I/O Management, Block Library)* (read status words)
- WRITE_PARAM *(see Unity Pro, I/O Management, Block Library)* (write adjustment parameters)
- READ_PARAM *(see Unity Pro, I/O Management, Block Library)* (read adjustment parameters)
- SAVE_PARAM *(see Unity Pro, I/O Management, Block Library)* (save adjustment parameters)
- RESTORE_PARAM *(see Unity Pro, I/O Management, Block Library)* (restore adjustment parameters)

These exchanges apply to a set of %MW objects of the same type (status, commands or parameters) that belong to a channel.

NOTE:

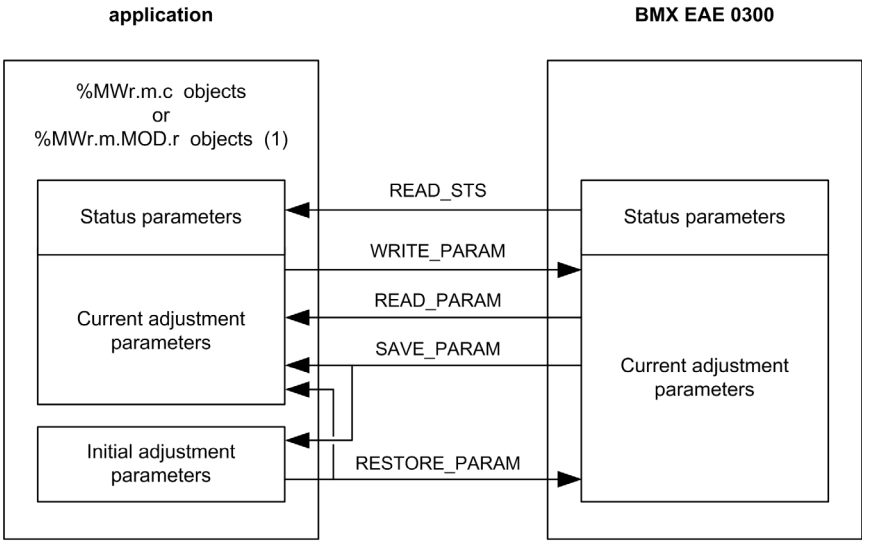
These objects can:

- provide information about the module (for example, type of channel detected error)
- define the module's operating modes (save and restore adjustment parameters in the process of application)

NOTE: In order to avoid several simultaneous explicit exchanges for the same channel, it is necessary to test the value of the word EXCH_STS (`%MWr.m.c.0`) of the IODDT associated to the channel before calling any EF addressing this channel.

General Principle for Using Explicit Instructions

The diagram below shows the different types of explicit exchanges that can be made between the application and module:



(1) Only with READ_STS instruction.

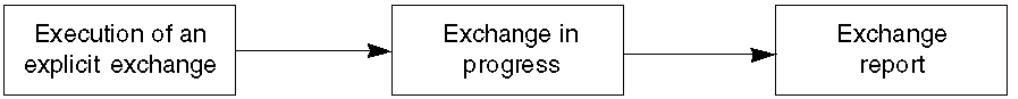
Managing Exchanges

During an explicit exchange, it is necessary to check performance to ensure data is only taken into account when the exchange has been correctly executed.

To do this, two types of information is available:

- information concerning the exchange in progress *(see Unity Pro, I/O Management, Block Library)*
- the exchange report *(see Unity Pro, I/O Management, Block Library)*

The following diagram describes the management principle for an exchange:



NOTE: In order to avoid several simultaneous explicit exchanges for the same channel, it is necessary to test the value of the word EXCH_STS (`%MWr.m.c.0`) of the IODDT associated to the channel before calling any EF addressing this channel.

Management of Exchanges and Reports with Explicit Objects

At a Glance

When data is exchanged between the PLC memory and the module, the module may require several task cycles to acknowledge this information. All IODDTs use two words to manage exchanges:

- `EXCH_STS` (`%MWr.m.c.0`): exchange in progress
- `EXCH_RPT` (`%MWr.m.c.1`): report

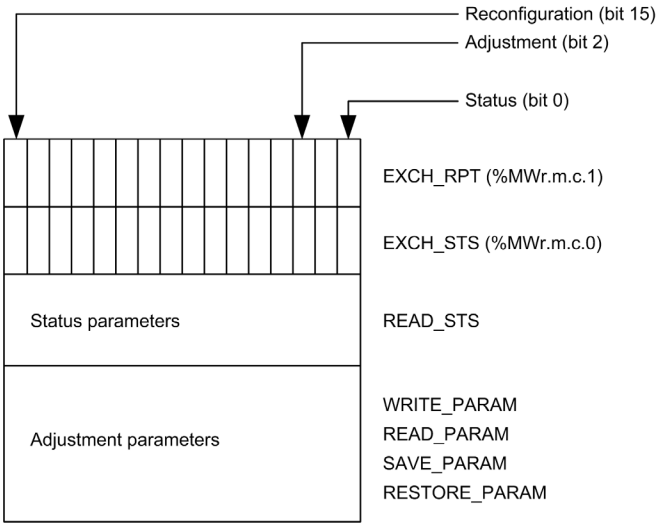
NOTE:

Depending on the localization of the module, the management of the explicit exchanges (for example, `%MW0.0.MOD.0.0`) are not detected by the application:

- For in-rack modules, explicit exchanges are done immediately on the local PLC bus and are finished before the end of the execution task. The `READ_STS`, for example, is always finished when the `%MW0.0.mod.0.0` bit is checked by the application.
- For remote bus (Fipio for example), explicit exchanges are not synchronous with the execution task, so the detection is possible by the application.

Bits for Managing Exchanges

The illustration below shows the different significant bits for managing exchanges:



Description of Significant Bits

Each bit of the words EXCH_STS (%MWr.m.c.0) and EXCH_RPT (%MWr.m.c.1) is associated with a type of parameter:

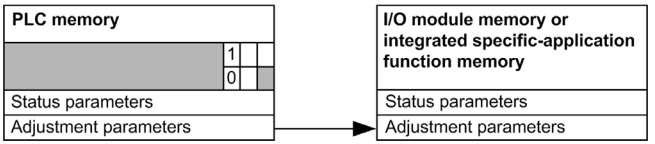
- Rank 0 bits are associated with the status parameters:
  - The STS_IN_PROGR bit (%MWr.m.c.0.0) indicates whether a read request for the status words is in progress.
  - The STS_ERR bit (%MWr.m.c.1.0) specifies whether a read request for the status words is accepted by the module channel.
- Rank 2 bits are associated with the adjustment parameters:
  - The ADJ_IN_PROGR bit (%MWr.m.c.0.2) indicates whether the adjustment parameters are being exchanged with the module channel (via WRITE_PARAM, READ_PARAM, SAVE_PARAM or RESTORE_PARAM).
  - The ADJ_ERR bit (%MWr.m.c.1.2) specifies whether the adjustment parameters are accepted by the module. If the exchange is correctly executed, the bit is set to 0.
- Rank 15 bits indicate a reconfiguration on channel **c** of the module from the console (modification of the configuration parameters + cold start-up of the channel).

NOTE: r represents the rack number, **m** the position of the module in the rack, while **c** represents the channel number in the module.

NOTE: Exchange and report words also exist at module level EXCH_STS (%MWr.m.MOD) and EXCH_RPT (%MWr.m.MOD.1) as per IODDT type T_GEN_MOD.

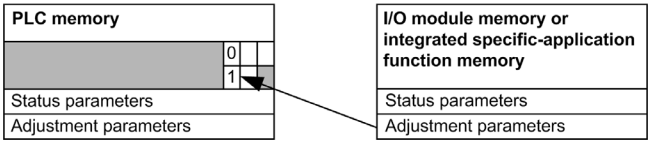
Data Exchange Example

Phase 1: Sending data by using the WRITE_PARAM instruction



When the instruction is scanned by the PLC processor, the **Exchange in progress** bit is set to 1 in %MWr.m.c.

Phase 2: Analysis of the data by the I/O module.



When the data is exchanged between the PLC memory and the module, acknowledgement by the module is managed by the ADJ_ERR bit (%MWr.m.c.1.2).

This bit's values are:

- **0:** correct exchange
- **1:** detected error in the exchange

NOTE: There is no adjustment parameter at module level.

Execution Indicators for an Explicit Exchange: EXCH_STS

The table below shows the control bits of the explicit exchanges: EXCH_STS (%MWr.m.c.0)

Standard symbol	Type	Access	Meaning	Address
STS_IN_PROGR	BIT	R	Reading of channel status words in progress	%MWr.m.c.0.0
Unused	BIT	R	Unused	%MWr.m.c.0.1
ADJUST_IN_PROGR	BIT	R	Adjust parameters exchange in progress	%MWr.m.c.0.2
RECONF_IN_PROGR	BIT	R	Reconfiguration of the module in progress	%MWr.m.c.0.15

NOTE: If the module is not present or is disconnected, explicit exchange objects (READ_STS for example) are not sent to the module (STS_IN_PROG (%MWr.m.c.0.0) = 0), but the words are refreshed.

Explicit Exchange Report: EXCH_RPT

The table below shows the report bits: EXCH_RPT (%MWr.m.c.1)

Standard symbol	Type	Access	Meaning	Address
STS_ERR	BIT	R	Detected error reading channel status words (1 = reading not done)	%MWr.m.c.1.0
Unused	BIT	R	Unused	%MWr.m.c.1.1
ADJUST_ERR	BIT	R	Detected error during an adjust parameter exchange (1 = exchange not done)	%MWr.m.c.1.2
RECONF_ERR	BIT	R	Error during reconfiguration of the channel (1 = reconfiguration not done)	%MWr.m.c.1.15

SSI Module Use

The following table describes what happens between a SSI module and the system after a power-on:

Step	Action
1	Power on.
2	The system sends the configuration parameters.
3	The system sends the adjust parameters by `WRITE_PARAM` method. **Note:** When the operation is finished, the bit `%MWr.m.c.0.2` switches to 0.

If, in the begining of your application, you use a `WRITE_PARAM` command, you must wait until the bit `%MWr.m.c.0.2` switches to 0.

9.2 Language Objects and IODDTs Associated with the SSI Function

At a Glance

An integrated application-specific interface or the addition of a module automatically enhances the language objects application used to program this interface or module.

These objects correspond to the input/output images and software data of the module or integrated application-specific interface.

What Is in This Section?

This section contains the following topics:

Topic	Page
General Information	74
Implicit Exchange Objects for the T _SSI_BMX IODDT	75

General Information

General

The SSI modules have two associated IODDTs. These IODDTs are predefined by the manufacturer and contains language objects for inputs/outputs belonging to the channel of an application-specific module.

The IODDT associated with the SSI modules are:

- language objects at Module Level of the SSI Module (`T_GEN_MOD`)
- language objects associated with the SSI channel 0, 1 or 2 (`T _SSI_BMX`)

IODDT variables can be created in two different ways using the:

- **I/O objects** *(see page 91)* tab
- Data Editor *(see page 96)*

Each IODDT contains a set of language objects allowing its operation to be controlled and checked.

Implicit Exchange Objects for the T _SSI_BMX IODDT

At a Glance

The tables below present the T _SSI_BMX types IODDT implicit exchange objects which are applicable to the SSI module **BMX EAE 0300**.

In general, the meaning of the bits is given for bit status 1.

Not all bits are used.

Counter Value and Sensor Values

The table below presents the various IODDT implicit exchange objects:

Standard symbol	Type	Access	Meaning	Language object
SSI_CURRENT_VALUE	DINT	R	Current value of SSI register	%IDr.m.c.2
CAPTURE_0_VALUE	DINT	R	Value latched into Capture register 0	%IDr.m.c.4
CAPTURE_1_VALUE	DINT	R	Value latched into Capture register 1	%IDr.m.c.6
	DINT	R	Reserved	%IDr.m.c.8

%Ir.m.c Words

The table below presents the meanings of the bits of the %Ir.m.c words:

Standard symbol	Type	Access	Meaning	Language object
Reflex Output	EBOOL	R	Voltage level applied to the 24 Vdc channel output 0: 0 Vdc 1: 24 Vdc	%Ir.m.c.0
Reflex Output Latch	EBOOL	R	Logical state of internal channel Latch	%Ir.m.c.1
CAPT Input 0	EBOOL	R		%Ir.m.c.2
CAPT Input 1	EBOOL	R		%Ir.m.c.3

SSI Status, %IWr.m.c.0 Words

The following table presents the meanings of the bits of the %IWr.m.c.0 status words:

Standard symbol	Type	Access	Meaning	Language object
Reserved	BIT	R	Reserved	%IWr.m.c.0.0
Modulo Passing Flag	BIT	R	0: no modulo passing 1: modulo passing	%IWr.m.c.0.1
Capture 0 Flag	BIT	R	0: the capture 0 register is not updated 1: the capture 0 register is updated	%IWr.m.c.0.2

Standard symbol	Type	Access	Meaning	Language object
Capture 1 Flag	BIT	R	0: the capture 1 register is not updated 1: the capture 1 register is updated	%IWr.m.c.0.3
SSI Fram Error Flag	BIT	R	0: the SSI frame is correct 1: the line error such as the drop of line exists	%IWr.m.c.0.4
SSI Fram Status Error Flag	BIT	R	indicates a detected read data error	%IWr.m.c.0.5
SSI Parity Error Flag	BIT	R	0: parity correct 1: parity error	%IWr.m.c.0.6

Comparison Status, %IWr.m.c.1 Words

The following table presents the meanings of the bits of the %IWr.m.c.1 status words:

Standard symbol	Type	Access	Meaning	Language object
SSI_LOW	BIT	R	Current SSI value less than lower threshold (%QDr.m.c.4)	%IWr.m.c.1.0
SSI_WIN	BIT	R	Current SSI value is between lower threshold (%QDr.m.c.4) and upper threshold (%QDr.m.c.6)	%IWr.m.c.1.1
SSI_HIGH	BIT	R	Current SSI value greater than upper threshold (%QDr.m.c.6)	%IWr.m.c.1.2
CAPTURE0_LOW	BIT	R	Value captured in register 0 is less than lower threshold (%QDr.m.c.4)	%IWr.m.c.1.3
CAPTURE0_WIN	BIT	R	Value captured in register 0 is between lower threshold (%QDr.m.c.4) and upper threshold (%QDr.m.c.6)	%IWr.m.c.1.4
CAPTURE0_HIGH	BIT	R	Value captured in register 0 is greater than upper threshold (%QDr.m.c.6)	%IWr.m.c.1.5
CAPTURE1_LOW	BIT	R	Value captured in register 1 is less than lower threshold (%QDr.m.c.4)	%IWr.m.c.1.6
CAPTURE1_WIN	BIT	R	Value captured in register 1 is between lower threshold (%QDr.m.c.4) and upper threshold (%QDr.m.c.6)	%IWr.m.c.1.7
CAPTURE1_HIGH	BIT	R	Value captured in register 1 is greater than upper threshold (%QDr.m.c.6)	%IWr.m.c.1.8
THRESHOLD_ERROR	BIT	R	Lower threshold (%QDr.m.c.4) is greater than upper threshold (%QDr.m.c.6)	%IWr.m.c.1.9

Event Sources, %IWr.m.c.10 Words

The following table presents the meanings of the bits of the %IWr.m.c.10 words:

Standard symbol	Type	Access	Meaning	Language object
EVT_SOURCES	INT	R	Event sources field	%IWr.m.c.10
Reserved	BIT	R	Reserved	%IWr.m.c.10.0
MODULO	BIT	R	Event due to modulo switch	%IWr.m.c.10.1
Reserved	BIT	R	Reserved	%IWr.m.c.10.2
SSI_LOW	BIT	R	Event due to SSI value being less than lower threshold	%IWr.m.c.10.3
SSI_WINDOW	BIT	R	Event due to SSI value being between the two thresholds	%IWr.m.c.10.4
SSI_HIGH	BIT	R	Event due to SSI value being greater than upper threshold	%IWr.m.c.10.5
CAPTURE_0	BIT	R	Event due to capture function 0	%IWr.m.c.10.6
CAPTURE_1	BIT	R	Event due to capture function 1	%IWr.m.c.10.7
OVERRUNEVENT	BIT	R	Events have been lost	%IWr.m.c.10.9

Output Thresholds

The table below presents the various IODDT implicit exchange objects:

Standard symbol	Type	Access	Meaning	Language object
LOWER_TH_VALUE	DINT	R/W	Lower threshold value	%QDr.m.c.4
UPPER_TH_VALUE	DINT	R/W	Upper threshold value	%QDr.m.c.6

%Qr.m.c.d Words

The following table presents the meanings of the bits of the %Qr.m.c.d words:

Standard symbol	Type	Access	Meaning	Language object
OUTPUT_Force	EBOOL	R/W	1: the reflex output forced to "1". 0 and reflex block is disables: the reflex output returns	%Qr.m.c.0
REFLEX_Block	EBOOL	R/W	1: Output Block function enabled	%Qr.m.c.1

FUNCTIONS_ENABLING, %QWr.m.c.0 Words

The following table presents the meanings of the bits of the %QWr.m.c.0 words:

Standard symbol	Type	Access	Meaning	Language object
Reserved	BIT	R/W	Reserved	%QWr.m.c.0.0
Reserved	BIT	R/W	Reserved	%QWr.m.c.0.1
Reserved	BIT	R/W	Reserved	%QWr.m.c.0.2
VALID_CAPT_0	BIT	R/W	Capture authorization in the capture0 register	%QWr.m.c.0.3
VALID_CAPT_1	BIT	R/W	Capture authorization in the capture1 register	%QWr.m.c.0.4
COMPARE_ENABLE	BIT	R/W	Comparators operation authorization	%QWr.m.c.0.5
COMPARE_SUSPEND	BIT	R/W	Comparator frozen at its last value	%QWr.m.c.0.6

EVENT_SOURCES_ENABLING, %QWr.m.c.1 Words

The following table presents the meanings of the bits of the %QWr.m.c.1 words:

Standard symbol	Type	Access	Meaning	Language object
Reserved	BIT	R/W	Reserved	%QWr.m.c.1.0
EVT_MODULO_ENABLE	BIT	R/W	EVENT task called when there is a SSI module passing	%QWr.m.c.1.1
Reserved	BIT	R/W	Reserved	%QWr.m.c.1.2
EVT_SSI_LOW_ENABLE	BIT	R/W	EVENT task call when the SSI value is less than lower threshold	%QWr.m.c.1.3
EVT_SSI_WINDOW_ENABLE	BIT	R/W	EVENT task call when the SSI value is between the lower and upper threshold	%QWr.m.c.1.4
EVT_SSI_HIGH_ENABLE	BIT	R/W	EVENT task call when the SSI value is greater than the upper threshold	%QWr.m.c.1.5
EVT_CAPT_0_ENABLE	BIT	R/W	EVENT task call during capture in register 0	%QWr.m.c.1.6
EVT_CAPT_1_ENABLE	BIT	R/W	EVENT task call during capture in register 1	%QWr.m.c.1.7

9.3 The IODDT Type T_GEN_MOD Applicable to All Modules

Language Objects of the IODDT of Type T_GEN_MOD

Introduction

All the modules of Modicon M340 PLCs have an associated IODDT of type T_GEN_MOD.

In general, the meaning of the bits is given for bit status 1.

Not all bits are used.

List of Objects

The table below presents the objects of the IODDT at module level:.

Standard Symbol	Type	Access	Meaning	Address
MOD_ADDRESS		R	Language element of module level used for READ_STS	%CHr.m.MOD
MOD_ERROR	BOOL	R	Detected module error bit	%Ir.m.MOD.ERR
EXCH_STS	INT	R	Detected module exchange status	%MWr.m.MOD.0
STS_IN_PROGR	BOOL	R	Reading of status words of the module in progress	%MWr.m.MOD.0.0
EXCH_RPT	INT	R	Exchange report word	%MWr.m.MOD.1
STS_ERR	BIT	R	Event when reading module status words	%MWr.m.MOD.1.0
MOD_FLT	INT	R	Detected internal error word of the module	%MWr.m.MOD.2
MOD_FAIL	BIT	R	Detected internal error, module inoperable	%MWr.m.MOD.2.0
CH_FLT	BIT	R	Inoperative channel(s)	%MWr.m.MOD.2.1
	BIT	R	Module in self-tests	%MWr.m.MOD.2.3
CONF_FLT	BIT	R	Detected hardware or software configuration error	%MWr.m.MOD.2.5
NO_MOD	BIT	R	Module missing or inoperative	%MWr.m.MOD.2.6

The table below presents the objects of the IODDT of channel:.

Standard Symbol	Type	Access	Meaning	Address
CH_ADDRESS		R	Language element of channel level used for explicit exchanges READ_STS, READ_PARAM, WRITE_PARAM, SAVE_PARAM and RESTORE_PARAM	%CHr.m.c
CH_ERROR	BOOL	R	Detected channel error bit	%Ir.m.c.ERR

Quick Start: SSI Module BMX EAE 0300 Implementation Example

III

Overview

This part provides an example using the SSI module BMX EAE 0300.

What Is in This Part?

This part contains the following chapters:

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12	Configuring the SSI Module BMX EAE 0300 on Unity Pro	91
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Example Overview

10

At a Glance

This chapter describes an overview of the example using the SSI module.

What Is in This Chapter?

This chapter contains the following topics:

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Example Introduction

At a Glance

The objective of the example is to give a full review of the SSI module implementation by creating an operational program.

This example describes the following steps of the SSI module BMX EAE 0300:

- Description of the process
- Hardware installation
- Software configuration
- Programming
- Diagnosis and debugging

NOTE: This example will not cover the installation of the M340 controller, the other expansions modules nor the calibration of the SSI encoder.

Requirements

The hardware needed to do this example is:

- Modicon M340 SSI module (BMX EAE 0300)
- An SSI encoder and its necessary cables
- A M340 controller with an digital I/O expansion
- A drive
- A computer with Unity Pro installed

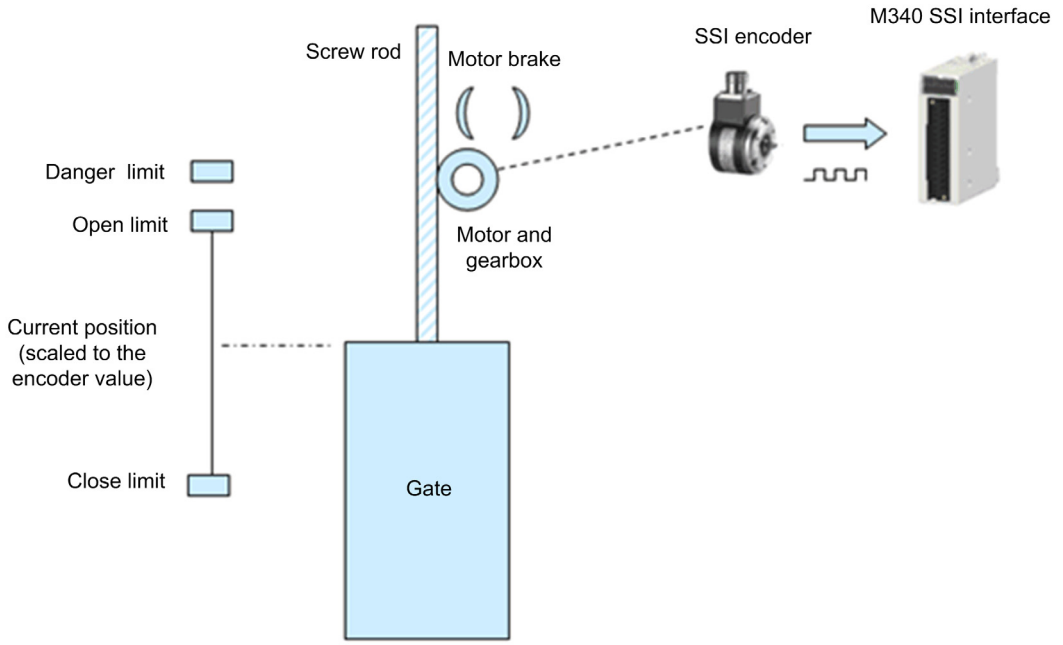
NOTE: Basic knowledge of Unity Pro programming and M340 controller installation is required for this example.

Application Background

Overview

The application example is a position control for the inlet gate of a dam using the SSI absolute encoder and M340 SSI interface module.

This system has an axis equipped with a drive for positioning the gate within the Open and the Close limits, in order to open, partially open or close the door for water inlet management.



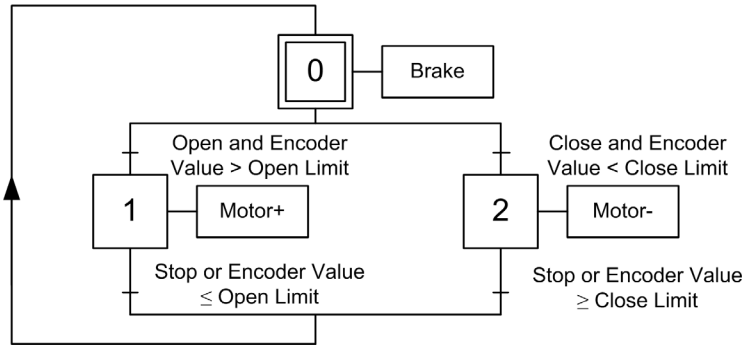
Process Description

The position of the gate is managed by a drive, and this drive is controlled with 3 buttons:
Open This button commands the drive to open the gate (`Motor+`)
Close This button commands the drive to close the gate (`Motor-`)
Stop This button commands the drive to stop and activates the drive brake (`Brake`)

The position of the gate is measured with an SSI absolute encoder.

The encoder data range of SSI absolute encoder is calibrated and scaled to the distance between the Open and the Close limits.

When the gate moves up or down, the SSI encoder installed at the gearbox shaft then translates the position into its encoder data before sending it to M340 SSI interface for position supervision and control.



Hardware Installation

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Overview

This chapter concerns the hardware installation, mounting and wiring of the SSI module BMX EAE 0300.

What Is in This Chapter?

This chapter contains the following topics:

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Mounting the Module and the Terminal Block

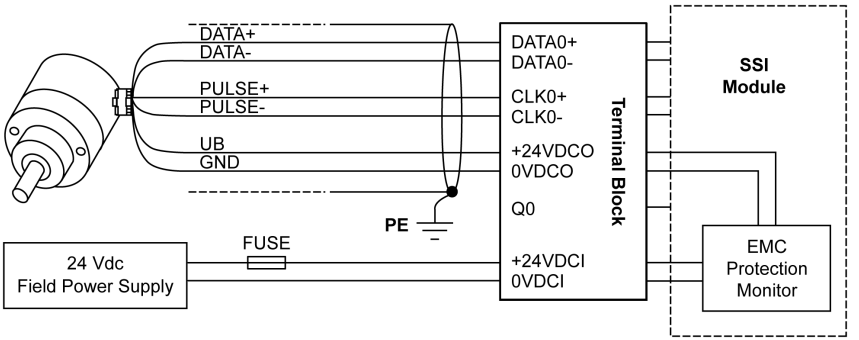
At a Glance

This part is fully described in the module installation *(see page 19)*.

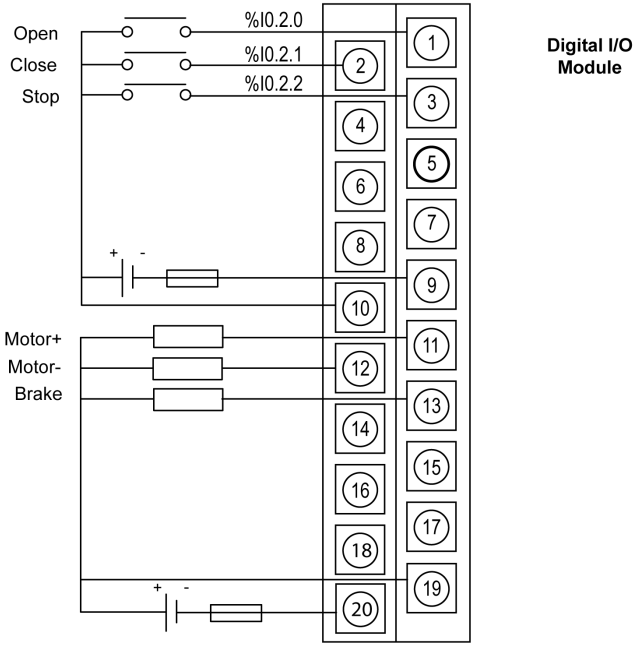
Wiring Diagram of the Process

Wiring Diagrams

The wiring diagram below shows the wiring of an SSI encoder to the SSI module:



The wiring diagram below shows the wiring of the necessary inputs and outputs of this example to a digital I/O module:



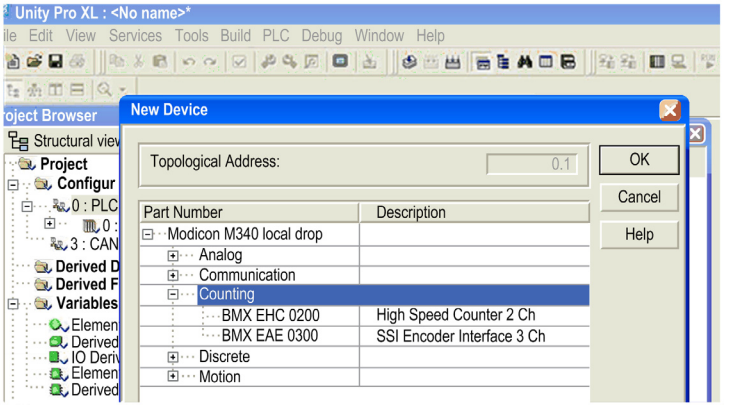
Configuring the SSI Module BMX EAE 0300 on Unity Pro

12

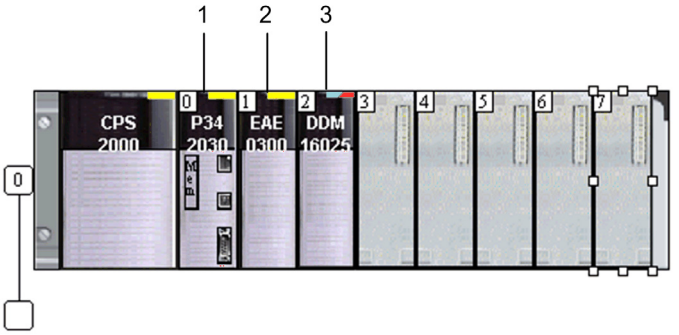
Configuration of the SSI Module BMX EAE 0300

Module Selection

In order to add a BMX EAE 0300 module, a project with an M340 controller has to be created. Once created, follow this procedure in order to add the SSI module:

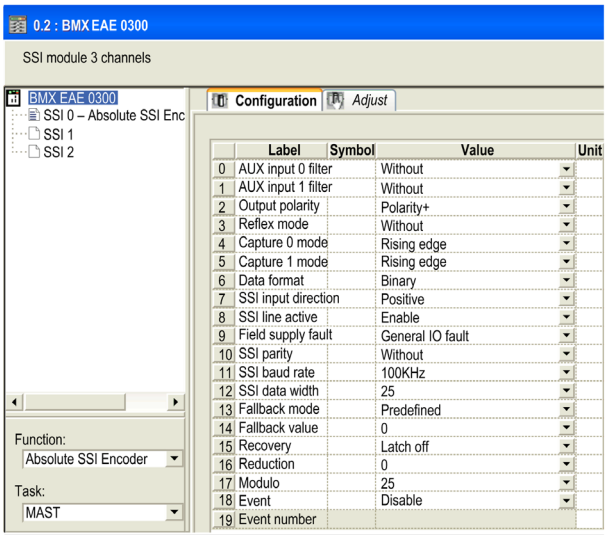
Step	Action
1	In the **Project browser** double-click on **Configuration** then on `0:Bus X` and on `0:BMX XBP •••`
2	In the `Bus X` window, select slot 1 and double-click
3	Choose the BMX EAE 0300 SSI module  Unity Pro XL : <No name>* ile Edit View Services Tools Build PLC Debug Window Help oject Browser Structural view Project Configur 0 : PLC 3 : CAN Derived D Derived F Variables Elemen Derived IO Deriv Elemen Derived New Device Topological Address: 0.1 OK Cancel Help Part Number Description Modicon M340 local drop Analog Communication Counting BMX EHC 0200 High Speed Counter 2 Ch BMX EAE 0300 SSI Encoder Interface 3 Ch Discrete Motion
4	Confirm with OK.

NOTE: For the purpose of the example, also add a digital I/O module to the configuration.



Configuring the Module

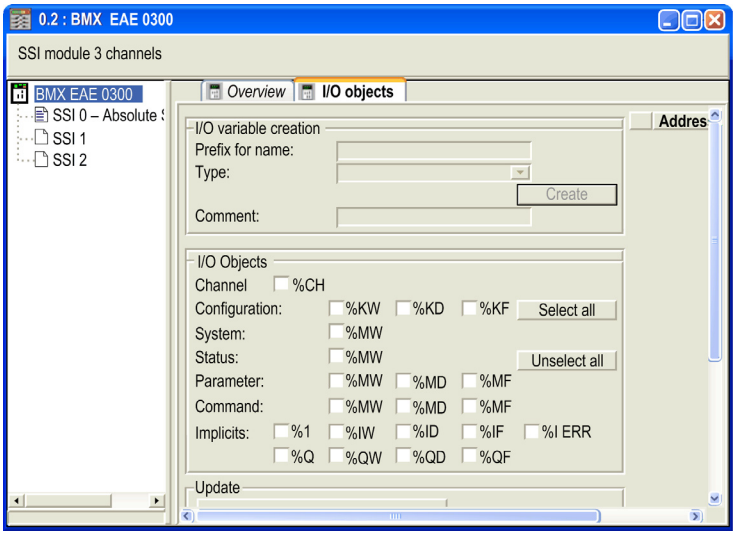
Once the module is added to the controller configuration, it is necessary to set which SSI channel will be used:

Step	Action
1	Select the first channel **SSI 0**
2	In the **Function** drop menu select **Absolute SSI Encoder**
3	Configure the channel with the values shown in this screenshot: 

Create the I/O objects

In order to have access to the I/O of the module, it is necessary to declare the %CH object.

The table below shows the procedure for declaring the I/O Derived Variable:

Step	Action
1	In the BMX EAE 0300 configuration window (double click the module if the window is not opened) and select the **I/O objects** tab
2	Click on the **I/O object** prefix address %CH then on the **Update grid** button, the channel address appears in the **I/O object** grid
3	Click on the line %CH0.1.0 and then enter a channel name in the **Prefix for name** zone Name: Gate_Position
4	Click **Create** 

Programming the Example

13

Overview

This chapter provides a program to simulate the process.

What Is in This Chapter?

This chapter contains the following topics:

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Creating the Program	97
Transferring the Project between the Terminal and the PLC	98

Declaration of Variables

At a Glance

All of the variables used in the different sections of the program must be declared.

Undeclared variables cannot be used in the program.

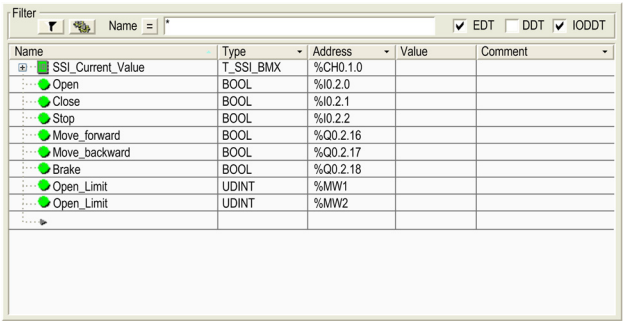
NOTE: For more information, see Unity Pro online help (click on help button, then **Unity →Unity Pro Software →Operating Modes →Data Editor**.

Variables Used for the Application

The following table shows the details of the variables used in the application.

Variable	Type	Definition
EDT variables		
`Open`	`BOOL`	Open command for the inlet gate
`Close`	`BOOL`	Close command for the inlet gate
`Stop`	`BOOL`	Stop command for the inlet gate
`Motor_Forward`	`BOOL`	Open the inlet gate (Motor+)
`Motor_Backward`	`BOOL`	Close the inlet gate (Motor-)
`Brake`	`BOOL`	Blocks the inlet gate
`Open_Limit`	`UDINT`	Open limit
`Close_Limit`	`UDINT`	Close limit
IODDT variable		
`Gate_Position`	`T_SSI_BMX`	IODDT of type T_SSI_BMX for the %CH0.1.0 address

The following screen shows the application variables and their address created using the data editor:



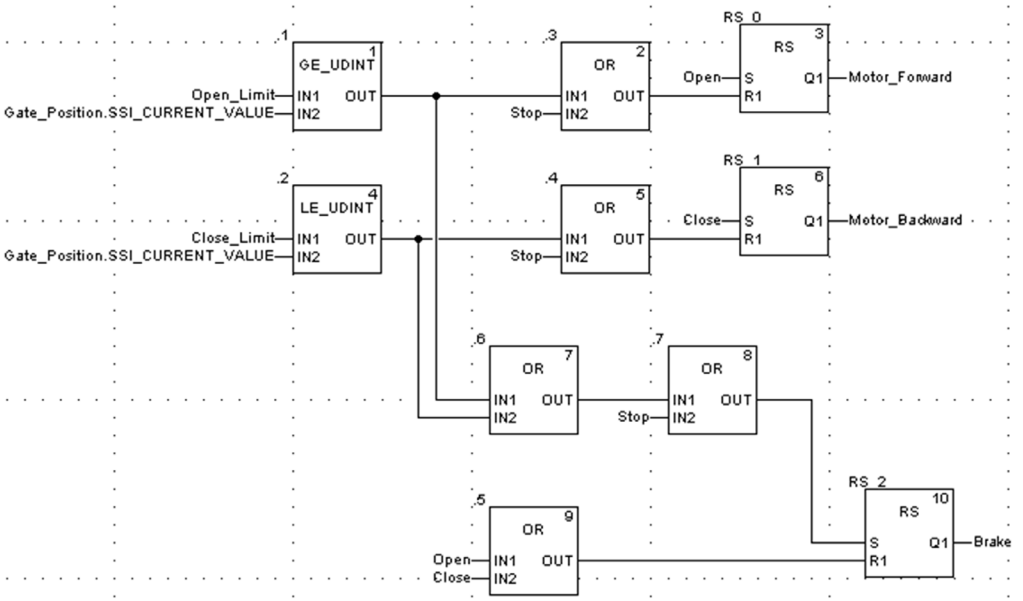
NOTE: Click on ⊞ in front of the derived variable `Gate_Position` to expand the I/O objects list.

Creating the Program

Illustration of the Program Section

This section below is part of the MAST task.

It has no condition defined for it so it is permanently executed:



Transferring the Project between the Terminal and the PLC

At a Glance

Transferring a project allows you to copy the current project from the terminal to the current PLC's memory (PLC that has its address selected).

Project Analysis and Generation

To perform analysis and generation of a project at the same time, carry out the following actions:

Step	Action
1	Activate the **Rebuild All Project** command in the **Build** menu. **Result:** the project is analyzed and generated by the software.
2	Detected errors are displayed in the information window at the bottom of your screen.

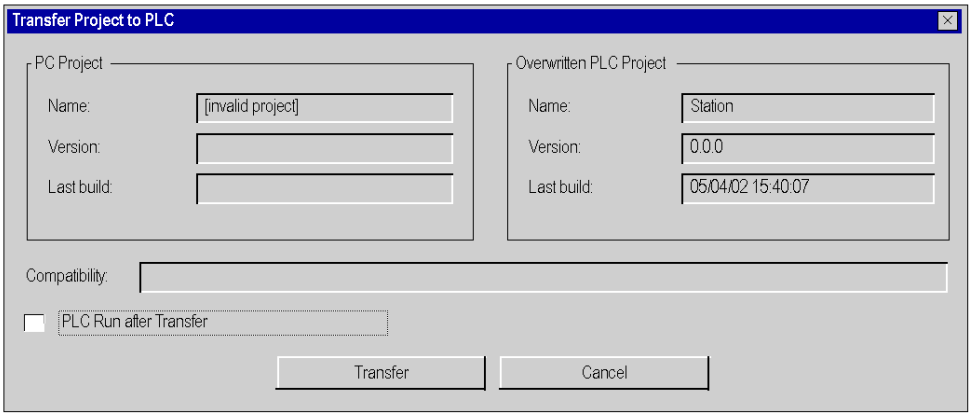
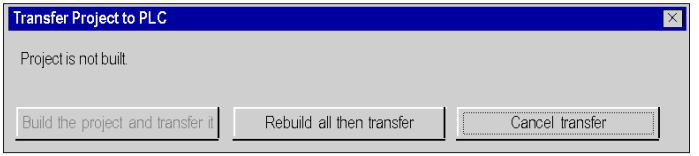
Project Backup

To back up the project, carry out the following actions:

Step	Action
1	Activate the **Save As** command in the **File** menu.
2	If necessary, select the directory to which the project will be saved (disk and path).
3	Enter the file name: **EXAMPLE_SSI**.
4	Confirm with **Save**. **Result:** the project is saved as **EXAMPLE_SSI.STU**.

Transferring the Project to the PLC

You must carry out the following actions to transfer the current project to a PLC:

Step	Action
1	Use the **PLC →Define the address** command. Enter **SYS** if you are using a **USB** media that is directly connected from the PC (terminal) to the PLC.
2	Switch to online mode using the **PLC →Connection** command.
3	Activate the **PLC →Transfer Project to PLC** command. **Result**: the screen used to transfer the project between the terminal and the PLC is displayed: 
4	Activate the **Transfer** command.
5	If the project has not been generated in advance, the screen below will be displayed allowing you to generate it before the transfer (**Rebuild All then Transfer**) or interrupt the transfer (**Cancel Transfer**). 
6	Transfer progress is displayed on screen. At any moment, you can interrupt the transfer by using the **Esc** key. In this case, the PLC project will be invalid. **Note**: In the event that the project is transferred to a Flash Eprom memory card, the transfer can take several minutes.

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Diagnostic and Debugging

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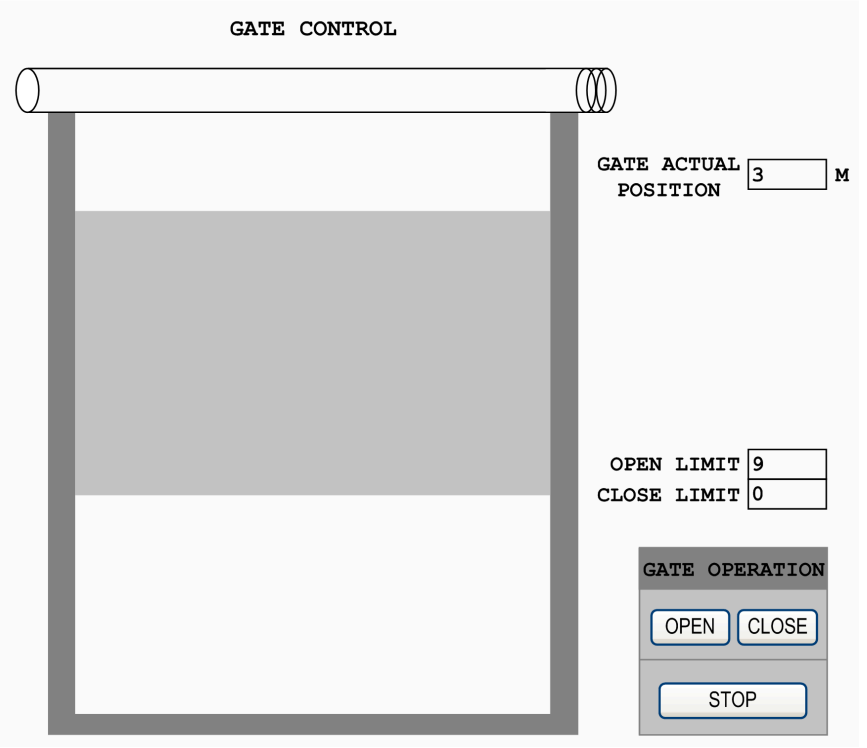
Monitor the Application

At a Glance

Create an operator screen for the application:



NOTE: For more information, see Unity Pro online help (click on ?, then `Unity`, then `Unity Pro`, then `Operate modes`, and `Operator screens)`.